Quarterly Bulletin

Autumn 2005

Bank of England

Volume 45 Number 3

Foreword

Every three months, the Bank of England publishes economic research and market reports in its *Quarterly Bulletin*. This quarter, the *Bulletin* includes analysis of the forecasting record of the Bank's Monetary Policy Committee (MPC), as well as of the long-run relationship between money and inflation. The *Bulletin* also reports on proposed changes to publication of the Bank's narrow money data.

Ever since its inception in 1997, the MPC has recognised the importance of regular assessments of its forecast performance, as a comparison of outturns with the Committee's projections can help shed light on shortcomings both in economic modelling and in MPC thinking. The article *Assessing the MPC's fan charts*, by Rob Elder, George Kapetanios, Tim Taylor and Tony Yates, sets out a number of criteria by which the MPC's forecasts can be judged. It then draws a range of conclusions about the Committee's track record.

The article looks at both the MPC's mean projections (a measure of central tendency) for GDP growth and inflation, as well as the MPC's fan charts as a whole. The likelihood of any central projection actually occurring is small, and the fan charts published by the MPC in its quarterly *Inflation Report* summarise the uncertainty surrounding the central projections for growth and inflation. Analysing the forecasts embodied in the fan charts as a whole — and not just the central projections — is an important element of any assessment of the MPC's track record. It is also important to recognise the limits of any analysis. As the MPC has only been responsible for monetary policy since 1997, the sample of forecasts available for analysis is small. Statistical analysis that uses small samples can be misleading.

Nevertheless, the work in this edition of the *Bulletin* suggests that the fan charts have given a reasonably good guide to the risks and probabilities facing the MPC. It also contains some potential lessons for the Committee: indeed, it was instrumental in the MPC's decision in its August 2005 *Inflation Report* to widen the GDP fan chart at short horizons. As well as suggesting that the GDP fan charts have been too narrow at short horizons, the article indicates that — at least in the early years of the MPC — the fan charts for both inflation and GDP growth may have been too wide at longer horizons. Over time, the MPC has narrowed both its inflation and GDP fan charts at longer horizons, in part reflecting the greater degree of economic stability. So it is less obvious that the current vintage of fan charts is overestimating the degree of uncertainty presently facing the MPC.

The relationship between the rate of expansion of the money supply and inflation has been of long-standing interest to economists. In *Long-run evidence on money growth and inflation*, Luca Benati uses data from as far back as the 19th century to analyse the movements in broad money growth, narrow money growth and inflation. He finds a remarkable degree of stability in the long-run relationship between money growth and inflation. In particular, the long-run relationship between money and inflation does not appear to be affected by the choice of monetary regime — be it the gold standard or today's monetary policy arrangements. But in the short to medium term, the

relationship between money growth and inflation can exhibit a considerable degree of instability.

The previous edition of the *Bulletin* reported on the plans to reform the Bank's money market operations. In this edition, the *Bulletin* looks at the potential implications of these changes for the narrow money data published by the Bank. At present, M0 — one of the Bank's narrow money series — comprises notes and coin in circulation as well as bankers' operational balances at the Bank of England. Following the implementation of the planned reforms to money market operations, bankers' balances are likely to increase greatly in size and be subject to very different influences from those driving notes and coin. The Bank is therefore proposing to discontinue the publication of an aggregate M0 series and instead publish separate series for notes and coin in circulation, and reserves of banks and building societies held with the Bank.

Charles Bean
Chief Economist and Executive Director for Monetary Policy, Bank of England.

This edition of the *Quarterly Bulletin* also includes:

- *Markets and operations*. This article reviews developments in sterling and global financial markets, in market structure and in the Bank's balance sheet since the Summer *Bulletin*; and

- *The determination of UK corporate capital gearing* (by Peter Brierley and Philip Bunn). This article seeks to explain the high level of UK corporate capital gearing. It finds that, in a standard economic model, the sharp rise in gearing between 1999 and 2002 cannot wholly be explained by a rise in the long-run equilibrium level of gearing. This could suggest that gearing has been above a sustainable level.

Bank of England Quarterly Bulletin

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Recent economic and financial developments

Research and analysis

MPC speeches

The contents page, with links to the articles in PDF, is available at www.bankofengland.co.uk/publications/quarterlybulletin/index.htm.
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The speeches contained in the *Bulletin* can be found at www.bankofengland.co.uk/publications/speeches/index.htm.

Volume 45 Number 3

Markets and operations

This article reviews developments since the Summer Quarterly Bulletin *in sterling and global financial markets, in market structure and in the Bank's balance sheet.*(1)

- *Sterling short-term market interest rates fell, as market participants appeared to revise downwards their views on the likely future path of monetary policy. Short-term euro rates also fell slightly whereas US dollar rates were little changed. Nominal forward rates at longer maturities declined across the major currencies.*
- *Global equity prices rose, despite market concerns about the economic impact of higher oil prices, which may have reflected a decline in real interest rates, robust profit growth, and perhaps lower risk premia.*
- *Credit spreads narrowed, which also suggested investors' appetite to take risk remained strong. Many manifestations of the recent 'search for yield' appeared to remain intact.*
- *In July, the Bank published the draft legal and operational documentation for its reformed sterling money market operations. And in August the Bank published a consultative paper describing proposals for managing the transition to the new arrangements.*

The world economy continued to grow robustly despite market concerns about further increases in oil prices. Reflecting this, global equity prices continued to rise. Movements in interest rates nonetheless suggested some variation in the cyclical position of individual economies (Table A).

In the United Kingdom, the official sterling interest rate was reduced by 25 basis points during the period, having remained unchanged for the previous twelve months. The expected path of future sterling interest rates was revised down, in part reflecting downward revisions to expectations of GDP growth (Chart 1). UK financial markets were not seriously disrupted by the bombings in London in July.

Policy rates in other major economies were unchanged or, in the case of the United States, raised in line with market expectations.

Against this backdrop, longer-term forward interest rates declined across major currencies in both nominal and real terms, and remained at low levels by historical standards. Yields on assets exposed to credit risk also declined and credit spreads narrowed, reversing some of the widening that had accompanied a period of stress at the beginning of May. More generally, the May credit

Table A
Summary of changes in market prices

	27 May	2 Sep.	*Change*
June 2006 three-month interbank interest rates (per cent)			
United Kingdom	4.50	4.25	*-25 bp*
Euro area	2.29	2.15	*-15 bp*
United States	4.07	4.06	*-1 bp*
Ten-year nominal forward rates (per cent)(a)			
United Kingdom	4.46	4.20	*-26 bp*
Euro area	4.32	3.99	*-33 bp*
United States	4.89	4.70	*-20 bp*
Equity indices (domestic currency)			
FTSE 100	4986	5327	*6.8%*
Euro Stoxx 50	3084	3274	*6.2%*
S&P 500	1199	1218	*1.6%*
Exchange rates			
Sterling effective exchange rate	100.2	101.0	*0.8%*
$/€ exchange rate	1.255	1.255	*0.0%*
Investment-grade credit spreads (basis points)			
Sterling-denominated	82	73	*-9 bp*
Euro-denominated	56	45	*-11 bp*
US dollar-denominated	105	89	*-16 bp*
Commodity prices (US dollars)			
Brent crude oil	49.65	65.57	*32.1%*

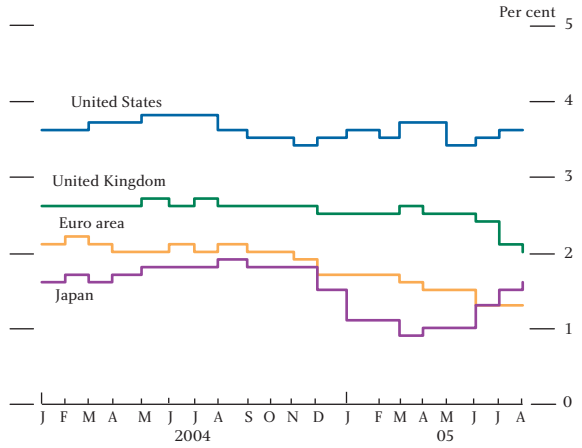
Columns may not correspond exactly due to rounding.

Sources: Bank of England, Bloomberg and Merrill Lynch.

(a) Three-month forward rates, derived from the Bank's government liability curves. Estimates of the UK curve are published daily on the Bank of England's website at www.bankofengland.co.uk/statistics/yieldcurve/index.htm.

(1) The period under review is 27 May (the data cut-off for the previous *Quarterly Bulletin*) to 2 September.

Chart 1
Expected real GDP growth for 2005



Source: Consensus Economics.

disturbance, which had been triggered by ratings downgrades of GM and Ford, does not appear to have had a sustained impact on financial markets despite some initial spillovers into other markets. In particular, fears of large-scale redemptions of investments in hedge funds at the end of June, which might have prompted liquidations of hedge fund positions in credit and other markets, appear not to have been borne out.

Indeed, neither the May credit market disturbance, nor the continued withdrawal of monetary accommodation in the United States, appear to have dented investors' risk appetite. Most of the manifestations of the recent 'search for yield' have remained intact. If compressed risk premia across asset prices reflected a degree of over-valuation, adjustment did not seem to have occurred during the review period. In this respect, potential risks to stability posed by any potential adjustment, as highlighted in recent issues of the Bank's *Financial Stability Review*, remain.

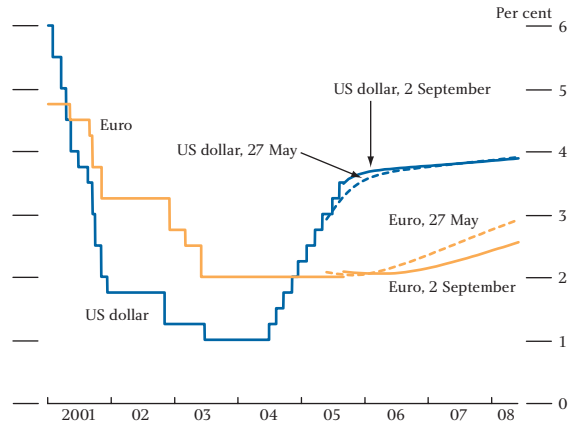
Short-term interest rates

Movements in short-term interest rates appeared to reflect differing cyclical positions across major international economies. As had been widely anticipated, US dollar official rates were increased by 50 basis points over the period, continuing the gradual withdrawal of monetary accommodation in the United States. Euro and yen official rates were unchanged; but the United Kingdom's Monetary Policy Committee (MPC) voted to reduce sterling official rates by 25 basis points, the first reduction since mid-2003.

Market participants' views on the likely path of future monetary policy reflected different near-term outlooks across countries. In the United States, data releases suggesting US economic growth remained robust initially contributed to a slight rise in the path of expected future interest rates through July (Chart 2). Towards the end of the period, however, US dollar implied rates fell sharply, reflecting concerns immediately after Hurricane Katrina about the economic impact of the associated increases in oil prices (Chart 3). By the end of the period, market prices were broadly consistent with two further 25 basis point increases in US dollar official rates by end-2006. Euro short-term forward rates fell slightly over the period, and remained consistent with expectations that official euro rates would remain on hold for the rest of the year.

Sterling interest rates implied by futures contracts expiring in June 2006 fell by around 25 basis points (Chart 3). The decline in the first half of the review period was apparently triggered by the *Minutes* of the

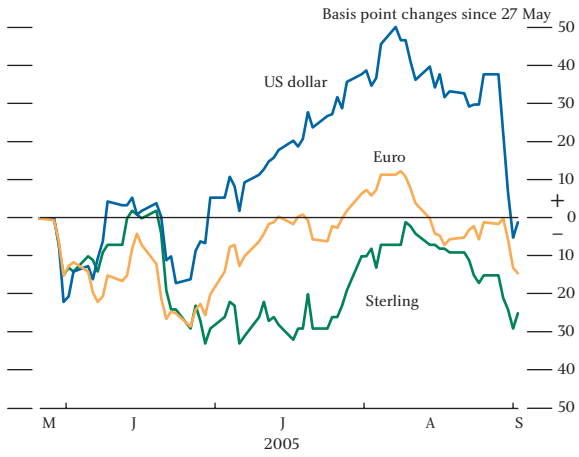
Chart 2
Short-term official interest rates and nominal forward rates(a)



Sources: Bank of England and Bloomberg.

(a) Two-week nominal forward rates implied by repo rates and government securities.

Chart 3
Cumulative changes in June 2006 interest rate futures contracts

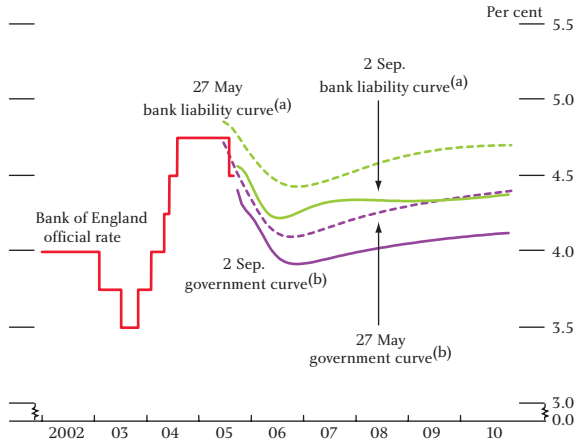


Sources: Bloomberg and Euronext.liffe.

June MPC meeting, which revealed that two MPC members had voted to reduce rates, and was reinforced by data showing downward revisions to UK GDP figures. Implied sterling rates rose slightly during early August but subsequently fell back, in part reflecting the immediate concerns about the fallout from the hurricane in the United States.

By 2 September, the sterling forward curve implied market expectations of at least one further 25 basis point reduction in official rates in the final quarter of 2005 or early 2006 (Chart 4). Chart 4 shows the path of one-day interest rates implied by market prices. In the past, the Bank has often used two-week forward rates as a guide to future short-term interest rates. But the Bank is seeking to control money market rates right up to the next MPC decision.(1) These rates always include the overnight rate. So, strictly, forward overnight rates are a cleaner measure of expectations of official rates. This technical change, which is unlikely to have any material effect on the level or shape of the forward curve derived, is explained further in the box on page 304.

Chart 4
Sterling official and forward market interest rates

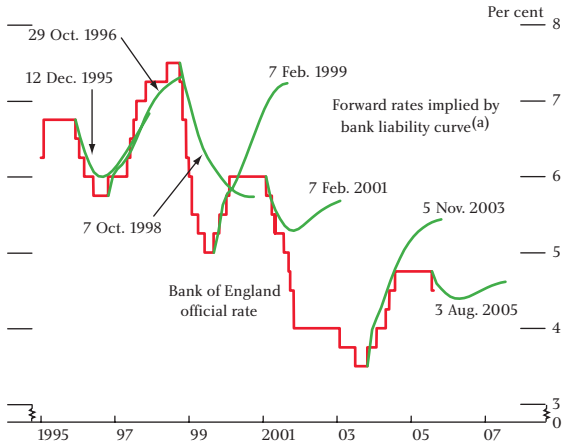


Sources: Bank of England and Bloomberg.

(a) One-day nominal forward rates implied by a curve fitted to a combination of instruments that settle on Libor.
(b) One-day nominal forward rates implied by GC repo/gilt curve.

The rate reduction in August followed a number of increases over the previous two years. Compared with the recent past, it is slightly unusual for the forward curve to be so flat following a change in the direction of official rates (Chart 5). But survey data suggested that this was consistent with economists' forecasts that any further near-term reduction in the official rate was expected to be modest. According to the September

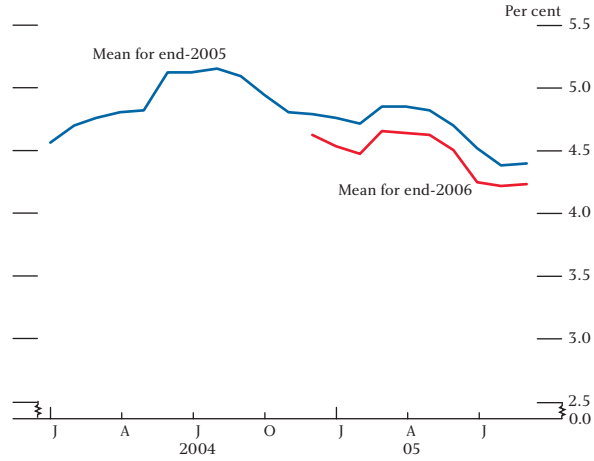
Chart 5
Bank of England official rate and nominal forward interest rates



Sources: Bank of England and Bloomberg.

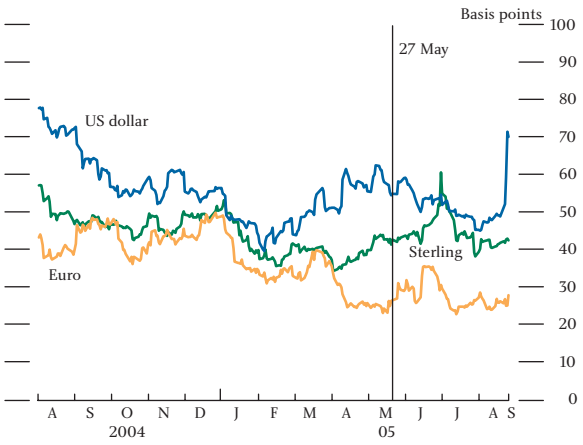
(a) Instantaneous forward rates implied by a curve fitted to a combination of instruments that settle on Libor.

Chart 6
Economists' forecasts for the Bank of England official rate



Source: Reuters.

Chart 7
Six-month implied volatility from interest rate options



Sources: Bank of England, Chicago Mercantile Exchange (CME) and Euronext.liffe.

(1) For more details, see 'Reform of the Bank of England's Operations in the Sterling Money Markets', available at www.bankofengland.co.uk/markets/money/smmreform050404.pdf.

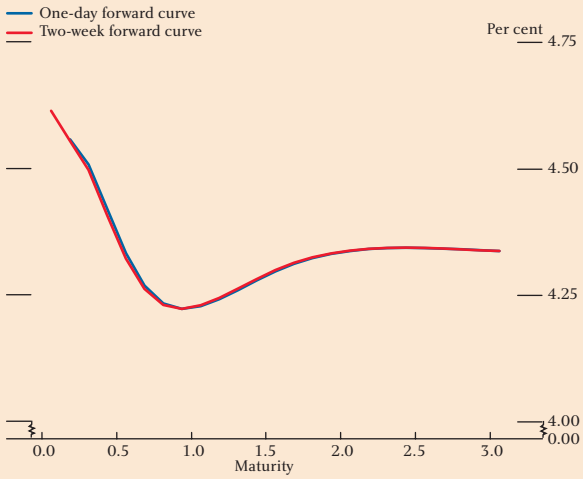
A change in the presentation of market forward interest rates

When presenting market expectations of official sterling interest rates, the Bank has in the past used two-week forward rates, reflecting the fact that it lends to the banking system at a maturity of around two weeks in its current open market operations.

As part of the review of its operations in the sterling money markets, the Bank announced last year that the primary objective of its operations would be to reduce volatility in overnight rates, establishing a flat money market yield curve, consistent with the official policy rate, out to the next MPC decision date.(1) This implies that overnight market interest rates should be in line with the official interest rate until the next MPC meeting. Consistent with this objective, the Bank has decided to use one-day forward rates to represent market expectations of the policy rate from now on.

This change will have limited practical significance, as one-day forward rates are typically very close to two-week forward rates at maturities beyond the very short term. For example, Chart A shows the one-day and two-week forward curves on 2 September 2005; the two curves are almost indistinguishable. Chart B shows how the difference between one-day and two-week forward rates depends on the slope of the yield curve. If the forward curve is perfectly flat, the two rates will be identical. Even in the presence of a very steep forward curve, the difference would be no more than a few basis points.

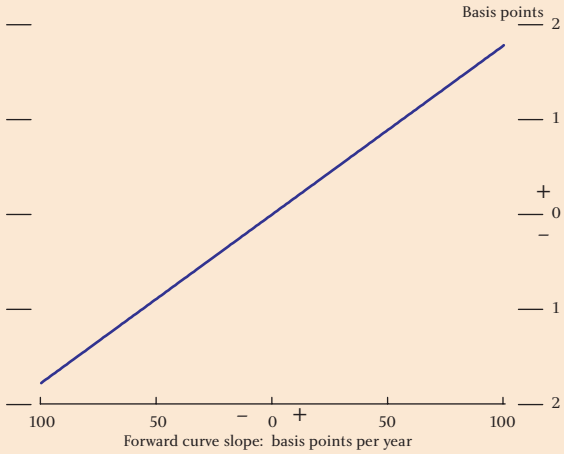
Chart A
One-day and two-week forward curves on 2 September 2005(a)



Sources: Bank of England and Bloomberg.

(a) Forward rates derived from a curve fitted to a combination of instruments that settle on Libor.

Chart B
Difference between two-week rate and one-day rate for given slope of forward curve(a)



Source: Bank of England calculations.

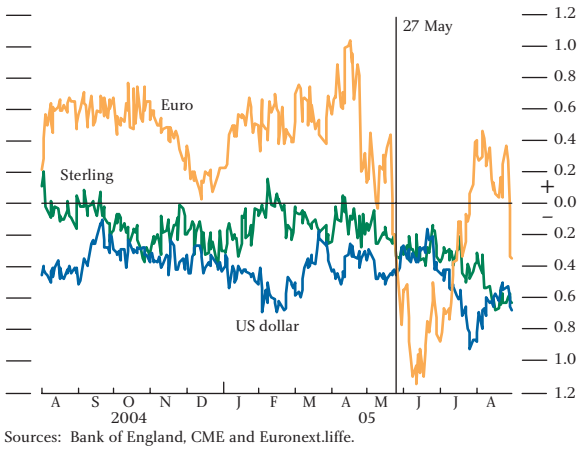
(a) Two-week less one-day forward rates for a given slope of a linear forward curve. For example, if the yield curve is linear, and the one year ahead one-day forward rate exceeds the current one-day rate by 100 basis points, then the current two-week rate will be around two basis points higher than the current one-day rate.

(1) See 'Reform of the Bank of England's Operations in the Sterling Money Markets, a second consultative paper', available at www.bankofengland.co.uk/markets/money/smmreform041125.pdf.

survey conducted by Reuters, the mean of economists' expectations for the official rate at the end of 2005 was 4.40%; for end-2006, the mean expectation was 4.23% (Chart 6). These figures were around 30 basis points lower than at the time of the previous *Bulletin*.

Measures of uncertainty about sterling interest rates, derived from options prices, were broadly unchanged over the period as a whole (Chart 7). But, in the run-up to the July MPC meeting, speculation about future interest rates contributed to a rise in implied volatility. This move was temporarily reinforced by the bombings in London on 7 July, which triggered a short-lived spike up in sterling interest rate uncertainty. Implied volatility

Chart 8
Six-month implied skew from interest rate options



Sources: Bank of England, CME and Euronext.liffe.

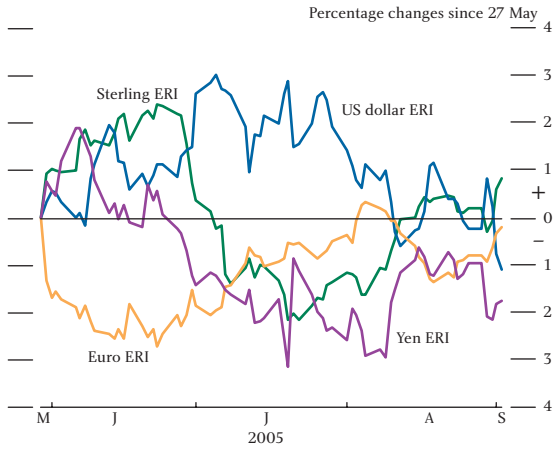
of short-term US dollar interest rates rose sharply towards the end of the period, reflecting uncertainty about the effects of Hurricane Katrina. But longer-term measures of uncertainty, implied by US dollar swaptions prices, changed little over the period, suggesting that the rise in near-term uncertainty was not expected to be sustained.

The balance of risks, implied by options prices, to both sterling and US dollar interest rates moved further to the downside over the period. Risks to euro-area rates initially moved sharply to the downside following the rejection of the EU constitution by voters in France and the Netherlands, but ended the period broadly unchanged (Chart 8).

Foreign exchange markets

Over the period, exchange rate movements were difficult to reconcile with changes in relative interest rates. The sterling exchange rate index (ERI) rose by 0.8% having been, at one point in July, more than 2% lower than its level at the time of the previous *Bulletin* (Chart 9). Other major ERIs fell over the period; the largest declines were in the yen ERI, which fell 1.8%, and the US dollar ERI, which ended the period 1.1% lower.

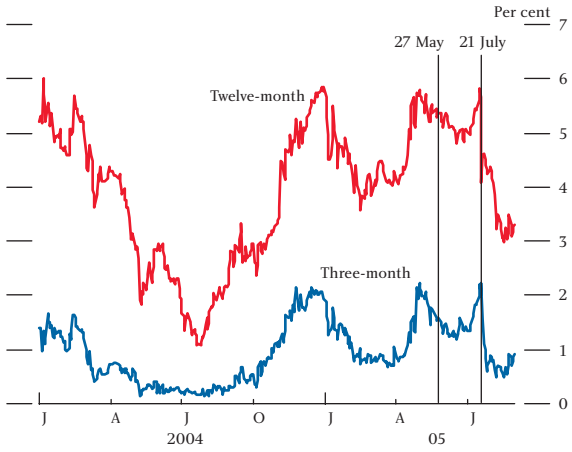
Chart 9
Cumulative changes in effective exchange rate indices



On 21 July, the Chinese authorities announced a change in the yuan exchange rate regime. The yuan was revalued against the dollar by 2.1% and moved to a managed float by reference to a basket of currencies. The exact composition of the reference basket has not been published, but the People's Bank of China (PBoC) has announced that it contains at least eleven currencies, with the US dollar, yen, euro and Korean won being the key components.

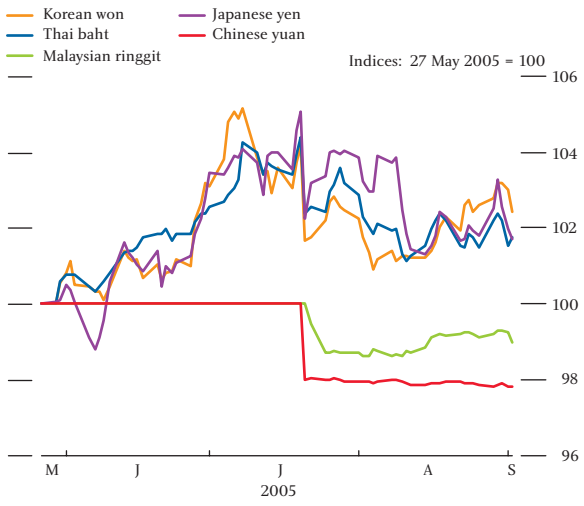
This change in the yuan regime had long been anticipated in prices of non-deliverable forwards (NDFs).(1) However, in the event, the revaluation was much smaller than had been expected. At the end of the review period, NDFs suggested that further yuan appreciation was still anticipated, and that the implied level of the yuan in twelve months' time was largely unchanged (Chart 10). Following the announcement, Asian currencies initially appreciated against the US dollar, although some of these moves partially unwound following the announcement by the PBoC that they were not planning further adjustments to the currency regime in the near term (Chart 11).

Chart 10
Appreciation in Chinese yuan implied by NDFs



Sources: Bloomberg and Bank of England calculations.

Chart 11
Change in Asian currencies per US dollar



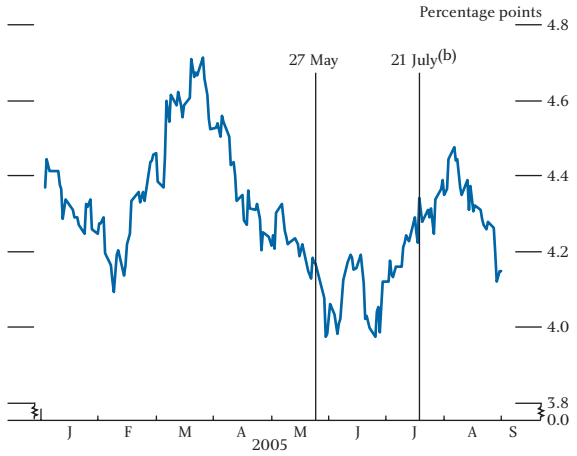
Sources: Bloomberg and Bank of England calculations.

(1) Non-deliverable forwards provide an offshore mechanism to hedge currencies that are otherwise difficult to hedge, either because no local forward market exists, or because foreign banks have only limited access to forward markets. In August, however, the PBoC issued new regulations allowing banks to trade yuan forwards on-shore.

Longer-term interest rates

Alongside indicators of strengthening activity in the United States, the decision to revalue the yuan may have been another factor that contributed to a rise in longer-term US dollar interest rates in the middle of the review period. In the two weeks following the Chinese announcement, ten-year US Treasury yields rose to a level around 30 basis points higher than at the time of the previous *Bulletin* before falling back again later in August (Chart 12).

Chart 12
Ten-year nominal US dollar spot rates(a)

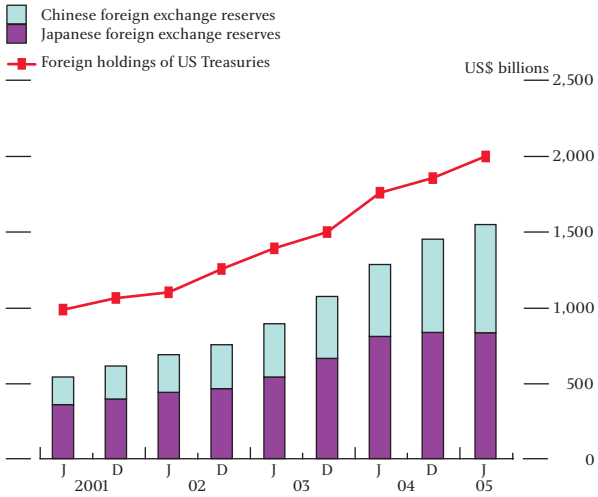


(a) Estimated from the Bank's government liability curve.
(b) On 21 July, the Chinese authorities announced a change in the yuan exchange rate regime.

Strong demand for US dollar-denominated assets from Asian investors, particularly central banks, has been one factor mentioned for some time by market participants in explaining the fall in US dollar long-term yields over the past couple of years. Market contacts have also suggested that tactical investment management by some Asian investors — buying bonds if yields reach the top of a given range, and selling if they fall to the bottom — may have contributed to low realised and implied volatility in bond markets. So the decision to revalue the yuan may have led to speculation about future reductions in the need for Asian central banks to buy US dollar-denominated assets to prevent their currencies from appreciating. But there is little evidence as yet to suggest that growth of foreign holdings of US Treasury bonds has slowed or that Asian central bank foreign exchange reserves have stopped accumulating (Chart 13).

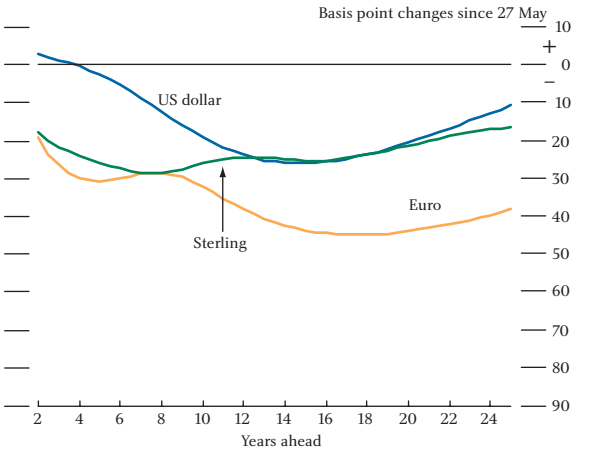
Internationally, ten-year *forward* rates fell by around 20–40 basis points over the period (Chart 14). Decomposing the movements in nominal long forward rates into real and inflation components suggests that

Chart 13
Foreign exchange reserves and foreign holdings of US Treasuries



Sources: IMF and US flow of funds.

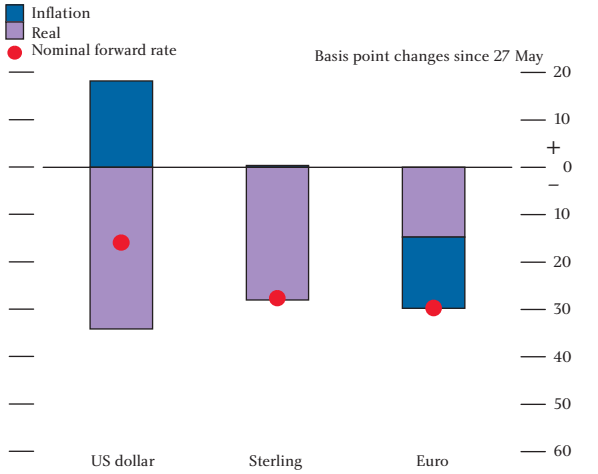
Chart 14
Changes in implied nominal forward rates(a)



Sources: Bank of England and Bloomberg.

(a) Instantaneous forward rates derived from the Bank's government liability curves.

Chart 15
Changes in nine-year nominal forward rates(a)



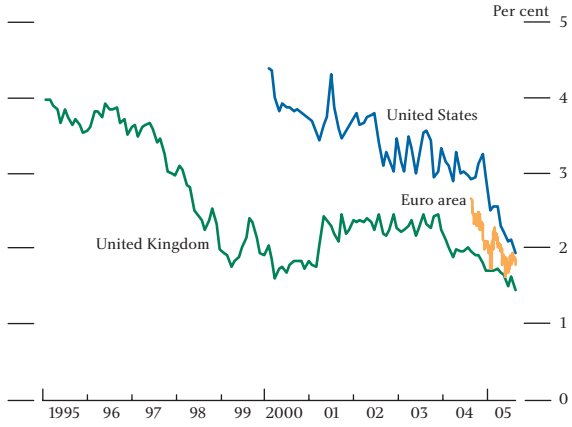
Sources: Bank of England and Bloomberg.

(a) Sterling and dollar real rates derived from the Bank's government liability curves. Real component of euro rates implied by nominal government bond yields less inflation swap rates, which may not be strictly comparable because of credit risk.

international long-horizon real forward rates declined over the period (Chart 15). Conceivably, this may in part have reflected some re-evaluation by investors of the potential impact of the further increases in oil prices on long-term global growth prospects.

The falls in real forward rates over the period continued the general downward trend since the start of last year (Chart 16). The precise factors underlying the low level of real long-term real interest rates remained unclear. Real interest rates should move to equate desired saving and planned investment. Desired saving depends on factors such as demographics, changes in asset values and households' uncertainty about future income flows. Planned investment is likely to be affected by factors such as productivity growth, labour force growth and investors' uncertainty about future rates of return. It is therefore possible that lower real interest rates reflected an adjustment to changes in these fundamental influences on savings and investment patterns around the world.(1)

Chart 16
International real nine-year forward rates(a)



Sources: Bank of England and Bloomberg.

(a) Instantaneous real forward rates derived from the Bank's government liability curve. Euro rates are implied from nominal government bonds less inflation swap rates, which may not be strictly comparable owing to credit risk.

One such influence that some commentators have suggested is a fall in the general level of macroeconomic volatility. But the theoretical link between macroeconomic volatility and observed long-term real yields is not straightforward.

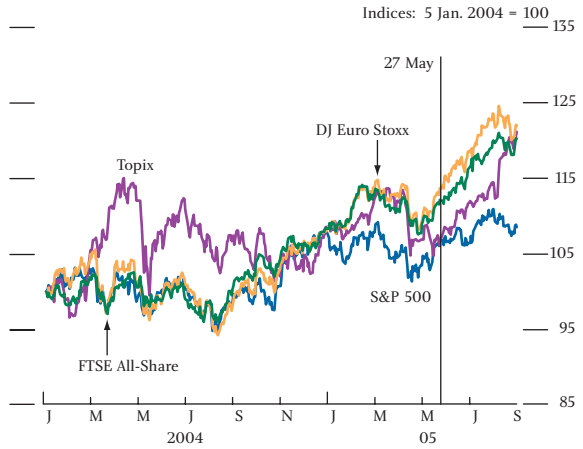
As explained in the box on pages 308–09, many consumption-based asset pricing models suggest that lower levels of macroeconomic volatility might be associated with higher expected (equilibrium) risk-free real interest rates, because less uncertainty encourages investors to reduce precautionary saving. This suggests that if a fall in macroeconomic volatility is to explain any of the observed fall in long-term real interest rates, it should have occurred via a fall in the risk premium associated with holding long-maturity index-linked government bonds (ie the required compensation for bearing uncertainty about future short-term real interest rates).

Other things equal, a fall in macroeconomic volatility should reduce the absolute size of risk premia across asset classes. Finance theory also suggests that, for individual assets, the size and sign of the associated risk premia depends on how the asset's pay-off co-varies with real consumption growth. If one-period returns on multi-period index-linked (credit risk free) bonds are positively correlated with consumption growth, lower macroeconomic volatility could have been a factor in lower long-term real interest rates, via lower risk premia. However, it is possible to construct plausible models where real returns are negatively correlated with consumption growth, and therefore require a negative risk premium. In this case, lower macroeconomic volatility might be expected to lead to a smaller negative risk premium, and therefore higher observed long-term real interest rates.

Equity markets

Lower long-term real interest rates would tend to support equity prices via lower discount rates on future earnings. And indeed, after weakening earlier in the year, international equity prices increased over the past few months, although they fell a little towards the end of the review period. The increases were most significant for the Euro Stoxx, the FTSE and the Topix indices (Chart 17).

Chart 17
International equity markets, domestic currency



Sources: Bloomberg, Thomson Financial Datastream and Bank of England calculations.

(1) This issue was considered in the boxes 'The fall in global long-term real interest rates' in the Spring 2005 *Quarterly Bulletin* and 'The economics of low long-term bond yields' in the May 2005 *Inflation Report*.

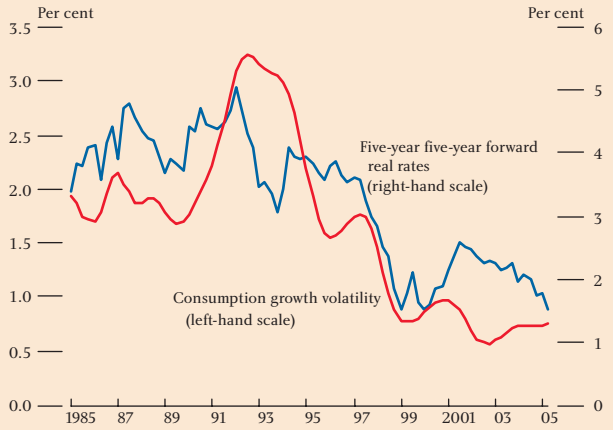
Real interest rates and macroeconomic volatility

International real interest rates remain low by historical standards. For example, sterling five-year real interest rates five years ahead (implied by index-linked gilts) have fallen to around 1.5%, compared with a post-1997 average of 2.1%.

Several macroeconomic explanations have been proposed for the low levels, including a rise in savings in Asian economies, sluggish investment growth in some economies, and a glut of corporate saving. Other contributing factors are often grouped under the umbrella of 'market factors'. These include regulatory change in some countries requiring long-term savings institutions to match better the future cash flows on their assets and liabilities; and a decline in liquidity premia on index-linked bonds.

Another explanation, based on macroeconomic fundamentals, is that the observed falls have in part been driven by a decline in the general level of macroeconomic volatility. Using the United Kingdom as an example, there does appear to have been some broad empirical association between the volatility of consumption growth and the level of real forward rates (Chart A).

Chart A
Sterling five-year, five-year forward real rates and volatility of consumption growth(a)



Sources: ONS and Bank of England calculations.

(a) Standard deviation of annual per capita consumption growth in the United Kingdom over a five-year rolling window.

In principle, macroeconomic volatility could influence yields on long-maturity bonds (and therefore implied forward rates) through two main channels:

- via the equilibrium level of risk-free interest rates (ie theoretical risk-free rates excluding any risk premia)
- by influencing the risk premia required for bearing uncertainty about future short-term interest rates and the value attached to the convexity(1) of long-term bonds.

Volatility and the expected risk-free interest rate

Much of modern asset pricing theory seeks to model the behaviour of a representative investor who must decide how much of his income to consume and how much to invest. In these models, interest rates are related to the expected growth of marginal utility and, in turn, to expected future consumption growth. When expected consumption growth is relatively high, agents may wish to borrow to smooth consumption over time, which would put upward pressure on interest rates.

Consumption-based asset pricing models assume a risk-averse agent who seeks to maximise a utility function.(2) Typically in these models, the equilibrium risk-free interest rate:(3)

- *increases* with the level of the agent's impatience (impatient agents require a higher return to saving to compensate for deferring consumption);
- *increases* with the expected growth rate of consumption; and
- *decreases* with the volatility of consumption growth.

The latter result arises because a risk-averse agent will seek to hold savings as a precautionary buffer in case income growth is unexpectedly low. Lower macroeconomic volatility, making these outturns less likely, should result in lower levels of such precautionary savings. In turn, the expected interest rate rises in order to maintain the supply of desired savings with planned investment. The more risk-averse the investor, the more pronounced should be the rise in the risk-free interest rate following a fall in volatility.

Assessing the size of the increase in the risk-free interest rate for a given fall in volatility is not straightforward. Simple consumption-based asset pricing models tend not to match observed movements in asset prices, resulting in several well-known 'puzzles'. For example, they often imply a level of risk-free interest rates that is greater than the level generally observed — the 'risk-free rate puzzle'.(4) But insofar as the models make some intuitive sense, they

(1) The longer the maturity of a bond, the more convex is the relationship between its price and yield. Convexity is valued because it serves to amplify the positive price impact of a fall in interest rates and to dampen price falls as interest rates rise. As a result, higher volatility means more value is attached to convexity, and yields on long-maturity bonds fall.
(2) The theory set out in this box implicitly assumes a power utility function, where utility, U, is related to consumption, C, via $U(C_t) = \left(C_t^{1-\gamma} - 1\right)/(1-\gamma)$, where γ characterises the representative agent's risk aversion.
(3) Note that these conclusions are based on comparative static arguments. The model assumes parameters such as impatience and macroeconomic volatility are fixed, and reflect the structure of the economy.
(4) Some of these puzzles are set out in Campbell, J Y (1999), 'Asset prices, consumption and the business cycle', in Taylor, J B and Woodford, M (eds), *Handbook of macroeconomics*, Chapter 19, Elsevier.

suggest that a fall in macroeconomic volatility should lead to higher not lower equilibrium risk-free rates. At the same time, lower macroeconomic volatility might lead investors to attach less value to the convexity of long-maturity bonds, which would put further upward pressure on long-term bond yields.

Volatility and the risk premium on long-maturity real bonds

The volatility of the macroeconomic environment influences the general price of market risk and, in turn, risk premia associated with all assets, including risk premia on government bonds. If investors expect the observed decline in macroeconomic volatility to be sustained, either because they expect the size of shocks hitting the economy to be smaller, and/or because they perceive that macroeconomic policy makers have become more able to offset shocks successfully, then the absolute size of risk premia may have fallen across asset classes.

The quantity of risk associated with any individual asset — and therefore its risk premium — is related to the covariance of the asset's pay-off with marginal utility and hence with consumption.(5) An asset with high expected returns when consumption is already high, and low expected returns when consumption is low will tend to add to consumption volatility, which investors are assumed to dislike. As compensation for this, investors will demand higher returns — a positive risk premium. Conversely, investors will require lower returns on assets that are expected to pay out more when consumption is low — ie there is a negative risk premium.

Many assets, such as equities, are typically assumed to have positive risk premia because their pay-off usually increases when the economy is growing robustly. But the situation may be less clear for index-linked government debt.

The price of index-linked government debt is determined by expectations of the future risk-free interest rate, which in turn depends on expected future consumption growth. This suggests that the sign of the risk premium associated with these assets depends crucially on how investors form expectations about future consumption growth.

Suppose investors believed that periods of unusually high consumption growth were expected to be followed by periods of below-trend growth and *vice versa*. Lower future consumption growth would suggest lower future real interest rates, which in turn would reduce yields on longer-maturity indexed bonds. This would cause the price of these bonds to rise (the principal of the bond would be discounted at a lower rate) and give the bondholder a capital gain. So in this scenario, holding period returns on long-maturity bonds (ie the return from holding a long-maturity bond for one period) might be expected to co-vary positively with consumption growth, implying a positive risk premium.(6)

Alternatively, if investors assume growth is persistent (so that a positive shock to consumption in one period causes some degree of upward revision to consumption growth expectations in subsequent periods), a favourable shock to current growth would, to some extent, raise growth expectations in subsequent periods. In turn, this would increase the real interest rate in subsequent periods, perhaps via a tightening of monetary policy, and the holder of a multi-period real bond would realise a capital loss. As such, holding period returns of long-maturity bonds would be negatively correlated with consumption growth, implying a negative risk premium.

It is difficult to know the exact mechanism through which investors form their expectations. As a result, even though the absolute size of any risk premium on index-linked bonds would likely decline given a sustained reduction in macroeconomic volatility, it does not necessarily follow that the observed level of long-term real interest rates would fall.

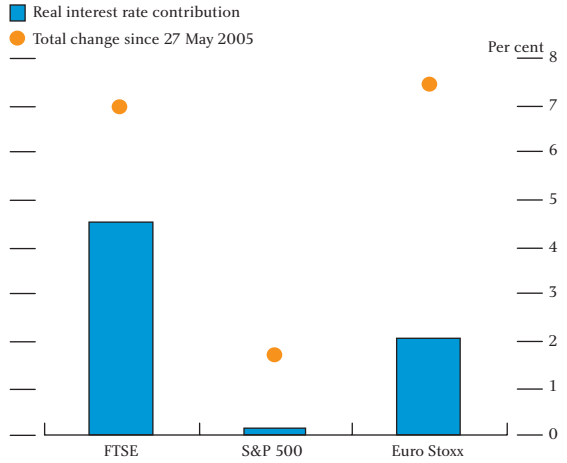
Reconciling the theory with the observed behaviour of real interest rates

Given the insights from these analytical models, what could explain the observed positive association between macroeconomic volatility and long real forward rates shown in Chart A? First and foremost, the models suggest that the underlying relationship is not straightforward; the apparent positive empirical association belies a much more complex structural relationship between the variables.

If long-dated real government bonds carry a positive risk premium, the fall in volatility could indeed account for some of the observed decline in real interest rates. Alternatively, if long-dated real government bonds currently have a *negative* risk premium, one could reconcile the observed moves with the analytical models if lower macroeconomic volatility had reflected structural changes which had also altered the risk characteristics of real government bonds. Specifically, if these structural changes had caused the expected covariance between real government bond returns and consumption growth to switch sign, then risk premia on government bonds might have shifted from being positive to negative. But if long-dated real government bonds have, and always have had, negative risk premia associated with them, then it would seem that alternative explanations are required to account for the observed decline in real interest rates.

(5) For more details on the price and quantity of risk, see Gai, P and Vause, N (2004), 'Risk appetite: concept and measurement', *Financial Stability Review*, December, pages 127–36.
(6) Risk premia are often positive in real term structure models. See for example Campbell, J Y (1986), 'Bond and stock returns in a simple exchange model', *Quarterly Journal of Economics*, Vol. 101, No. 4, pages 785–803; or Morgan Stanley (2005), 'A rough calibration of the UK real yield curve', for a more recent example.

Chart 18
Accounting for changes in equity prices: contributions of movements in real interest rates(a)



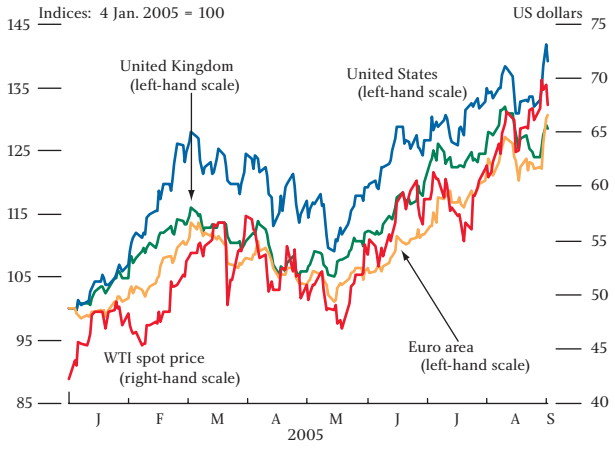
Sources: Bloomberg, Thomson Financial Datastream and Bank of England calculations.

(a) Based on simulations of a dividend discount model. The decomposition uses real interest rates from the Bank's government liability curves. For more details of such decompositions see Panigirtzoglou and Scammell (2002).

However, simulations of a simple dividend discount model suggest that, other things equal, falls in real interest rates are unlikely to have accounted fully for the continued strength in global equity markets over the review period (Chart 18).(1)

Some of the recent increases in equity prices could have reflected sector-specific developments. In particular, the continued strength of oil prices has boosted the share prices of oil and other companies in the resources sector (Chart 19).

Chart 19
Equity indices for resources sector (local currency) and WTI spot oil price

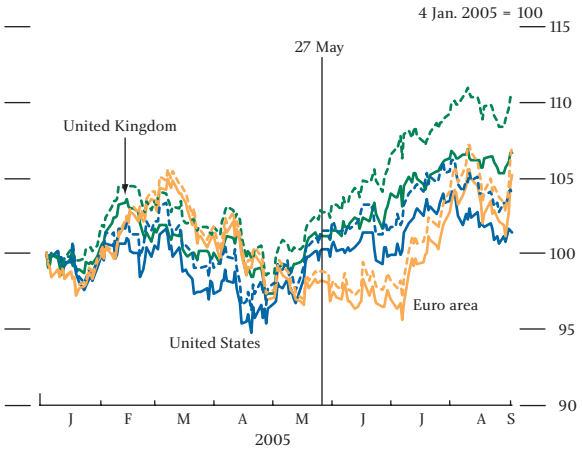


Sources: Bloomberg, Thomson Financial Datastream and Bank of England calculations.

At the same time, higher oil prices may have squeezed profit margins of non-oil companies. Anecdotal evidence suggests that the further increase in oil prices may have contributed to the slight weakening in equity prices over the final month of the review period. Nonetheless, even after excluding firms from the resources sector, UK, US and euro-area equity indices have all increased over the review period as a whole (Chart 20).

Moreover, a sectoral breakdown of equity price movements suggests that the increase over the period was quite broadly based across sectors, especially in the United Kingdom and the euro area (Chart 21). In fact, equity price movements of different sectors have tended to move more closely together over the past year than

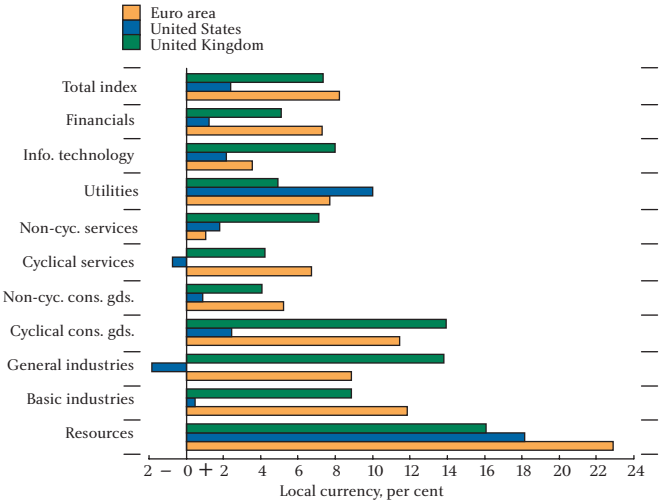
Chart 20
International equity indices excluding the resources sector(a)



Sources: Thomson Financial Datastream and Bank of England calculations.

(a) Dashed lines indicate Thomson Financial Datastream's total market indices in the United Kingdom, United States and euro area.

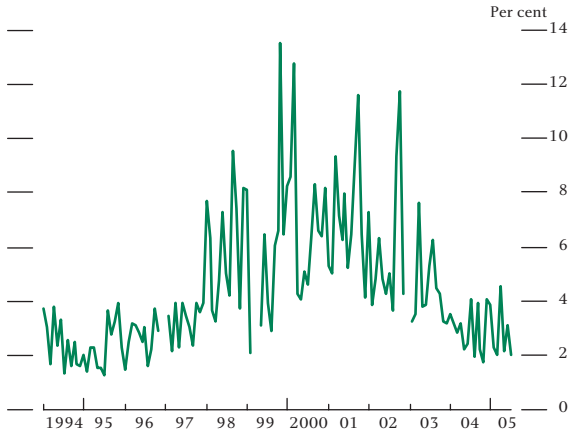
Chart 21
Changes in international sectoral indices since 27 May



Sources: Thomson Financial Datastream and Bank of England calculations.

(1) For more details on this decomposition, see Panigirtzoglou, N and Scammell, R (2002), 'Analysts' earnings forecasts and equity valuations', *Bank of England Quarterly Bulletin*, Spring, pages 59–66.

Chart 22
Standard deviation of monthly returns across FTSE sectors(a)



Sources: Bloomberg and Bank of England calculations.

(a) Returns calculated for each sector between first Wednesday of each month.

in previous years (Chart 22). This suggests that market-wide influences have been relatively more important than idiosyncratic factors over this period.

What other factors might explain the recent increases in stock prices? Reported company earnings growth has increased in 2005 and has generally exceeded market expectations, especially in the United States (Chart 23). Even in the United Kingdom, where output growth has slowed over the past year, aggregate corporate earnings have continued to increase faster than nominal GDP (Chart 24).

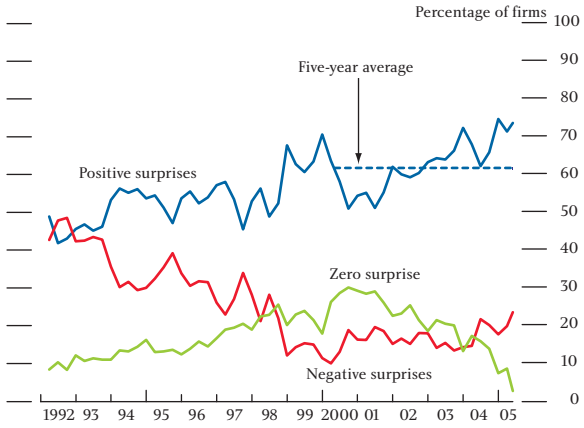
Against the background of higher earnings, the recent continued strength in equity prices does not look particularly unusual. Aggregate price to earnings ratios for both the S&P 500 and the FTSE All-Share have remained close to their averages since 1990 (Chart 25).

As well as increased earnings, the continued strength in global equity prices might have reflected further falls in equity risk premia. This would be consistent with low risk premia in other financial markets. But measures of uncertainty, implied by option prices, rose a little over the period for the major equity indices, although they remained low by recent historical standards (Chart 26).

Credit

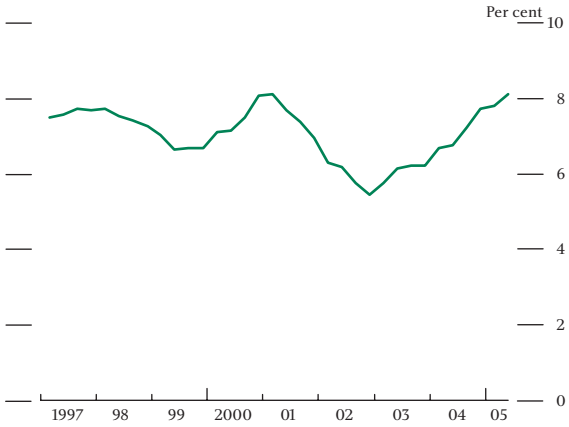
Accompanying higher equity prices, credit spreads on investment-grade corporate bonds and credit default swaps (CDS) narrowed over the period, and returned to the low levels observed at the start of 2005 (Charts 27 and 28). The narrowing appeared more pronounced on

Chart 23
S&P 500 quarterly company earnings surprises



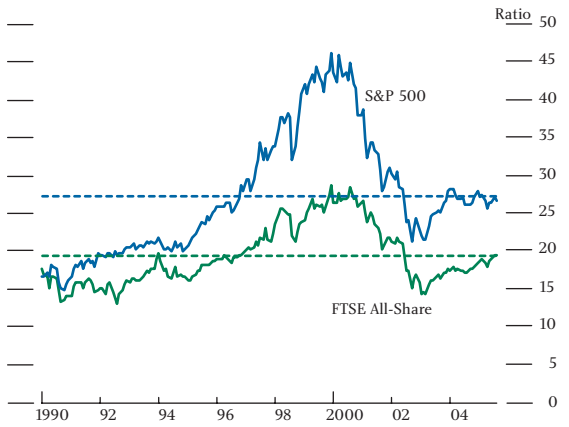
Sources: Bloomberg and Bank of England calculations.

Chart 24
FTSE All-Share company earnings as a percentage of nominal GDP



Sources: Bloomberg, ONS and Bank of England calculations.

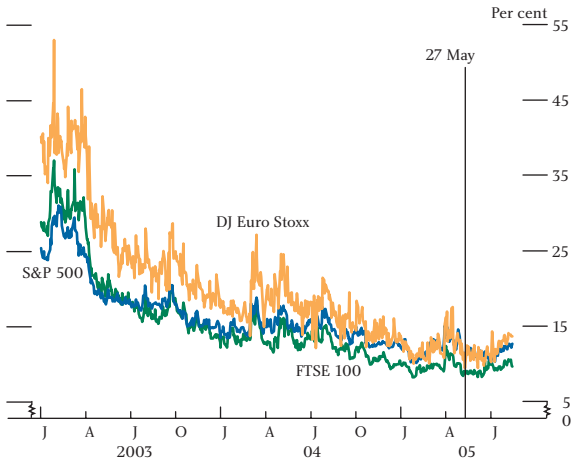
Chart 25
FTSE All-Share and S&P 500 price to earnings ratios(a)



Sources: ONS, Thomson Financial Datastream and Bank of England calculations.

(a) Based on a ten-year trailing average of earnings. Dashed lines represent the average price to earnings ratios since 1990.

Chart 26
Equity market implied volatilities (three-month constant maturities)



Sources: Bank of England, CME, Eurex and Euronext.liffe.

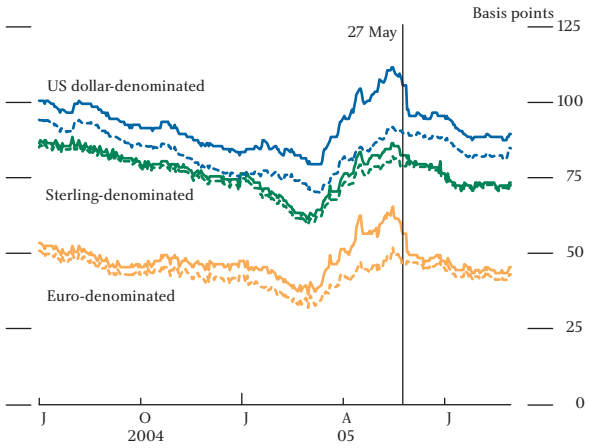
US dollar and euro-denominated spreads, though in part this reflected a change in index composition as car maker GM was removed at the end of May.

Spreads on high-yield and emerging market bonds also narrowed (Charts 29 and 30). Indeed, during the period the EMBI Global composite spread index tightened to the lowest level since the index began in 1998.(1) However, arguably in some markets investors may have become a little more discriminating over the period — the proportion of 'distressed' corporate debt (crudely defined as debt trading with a spread greater than 1,000 basis points) increased slightly.

More generally, the widespread narrowing in spreads could be consistent with a general improvement in credit quality. High-yield default rates touched an eight-year low during the period and are forecast to fall further in early 2006 (Chart 30). In addition, the renewed narrowing in spreads probably reflected reduced uncertainty surrounding credit markets, following a period of stress at the beginning of May.

In May, credit spreads widened, triggered by concerns related to the downgrades of GM and Ford. These downgrades were significant because, as noted in the Spring *Quarterly Bulletin*, outstanding GM and Ford debt is large relative to the total high-yield market.(2) At that time, dealers had appeared nervous about liquidations of positions in more risky and illiquid debt by some hedge funds, perhaps prompted by losses and actual or rumoured investor redemptions. A few contacts had

Chart 27
Option-adjusted corporate bond spreads(a)



Source: Merrill Lynch.

(a) Dashed lines exclude auto sector for US dollar and euro, and consumer cyclicals for sterling.

Chart 28
Spreads on credit default swap indices(a)

Source: JPMorgan Chase and Co.

(a) Five-year on-the-run Dow Jones CDX North American investment-grade index (DJ.CDX.NA.IG) and five-year on-the-run iTraxx Europe investment-grade index.

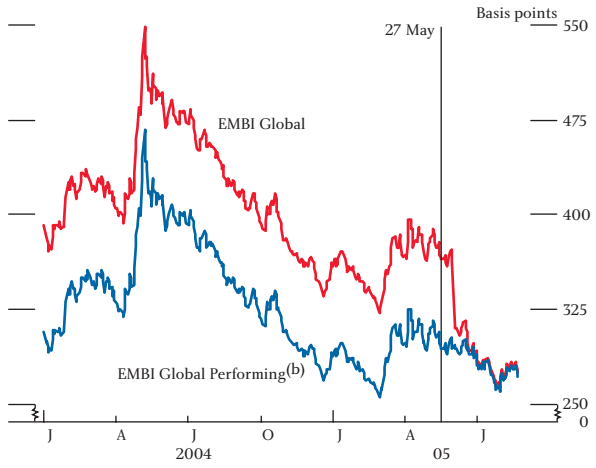
suggested that the widening of bid/offer spreads by dealers may have reflected this concern.

The downgrades also provided an interesting case study into the interaction of credit derivative and cash bond markets during a period of uncertainty. As outlined in the box on pages 314–15, differences in the liquidity of GM and Ford bonds and CDS contracts contributed to a sharp divergence in their relative prices.

High-yield debt issuance stalled in May, particularly in the bond market (Chart 31). Also, the pricing and issuance of several planned leveraged buy-outs (LBOs)

(1) Although it should be noted that the index fell by 50 basis points in June after it was rebalanced in response to Argentina's debt swap.
(2) For a more detailed account of the credit market stress in May, see Chapter 2 of 'The financial stability conjuncture and outlook', *Financial Stability Review*, June 2005, pages 50–70.

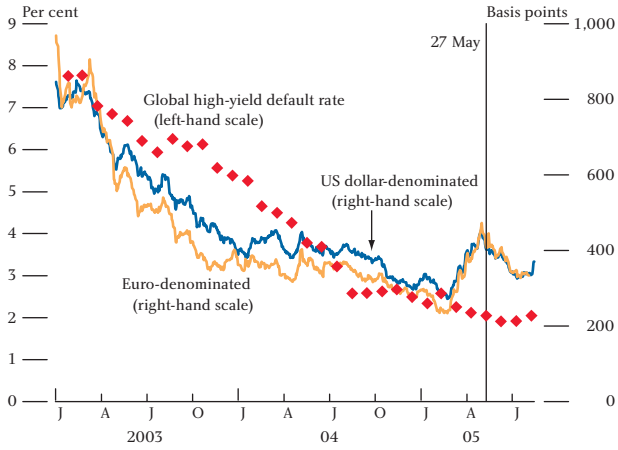
Chart 29
Emerging market sovereign bond spreads(a)



Source: JPMorgan Chase and Co.

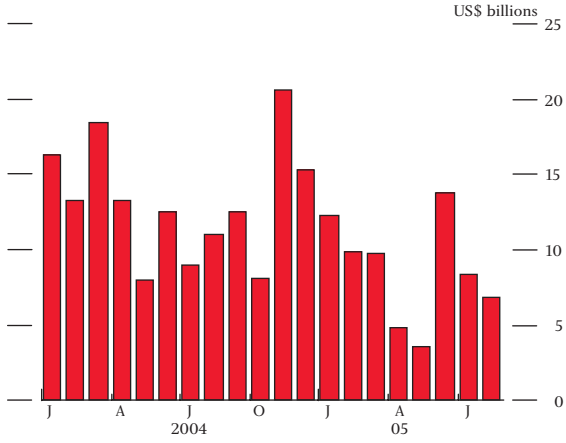
(a) Composite EMBI (Emerging Market Bond Index).
(b) Excludes defaulted bonds.

Chart 30
High-yield option-adjusted corporate bond spreads and twelve-month global default rate



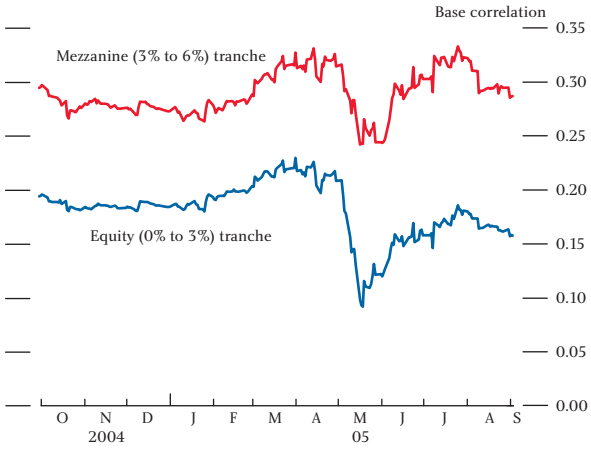
Sources: Merrill Lynch and Moody's.

Chart 31
Monthly high-yield bond issuance



Source: JPMorgan Chase and Co.

Chart 32
Base correlation of European CDS index equity and mezzanine tranches(a)



Source: JPMorgan Chase and Co.

(a) Five-year on-the-run iTraxx Europe investment-grade index. Base correlations calculated using heterogeneous gaussian copula model.

was delayed during May, and again following the London bombings on 7 July.

During May, there was also a significant disruption in structured credit markets, ie in markets for products that divide the credit risk on a diversified portfolio of credits into various 'tranches' that differ in their level of subordination. The value of the most risky (equity) tranches of structured credit products fell relative to that of tranches in the middle of the capital structure (mezzanine tranches), which translated into a fall in implied default correlation (ie a fall in the implied likelihood that a number of firms will default at the same time) (Chart 32). To some extent, this may have reflected a change in fundamentals, with idiosyncratic risk perceived as higher following the car maker downgrades and with continuing talk of LBOs elsewhere. But it also appears to have been a classic unwind of a 'crowded trade' with dealers and hedge funds, having been long equity tranches and short mezzanine tranches, having taken the view that continuing strong investor demand to take risk on mezzanine tranches had left these relatively expensive.

Most of these spillovers through the credit markets were short-lived. Credit spreads narrowed in June and July. High-yield bond issuance picked up and the decline in European LBO activity was only temporary — volume in 2005 Q2 was 28% greater than in the same period in 2004, and there were 13 deals over €500 million in the first half of the year. The payment-in-kind (PIK)(1) market, which investors had perceived as all but closed

(1) A PIK security gives the issuer the option of paying investors in similar securities instead of paying interest coupons. They are generally issued by high-risk companies who value the option of conserving cash.

Interactions between cash and derivatives markets

Liquidity in derivatives markets has grown rapidly in recent years, making it much easier for financial market participants to isolate and transfer financial risks. Under normal circumstances, the process of market arbitrage means the difference between prices in derivatives and underlying cash instruments is typically small. But occasionally prices may diverge, suggesting underlying market frictions (for example if liquidity is greater in the derivative market) and/or supply constraints in underlying cash instruments. This box reviews two recent examples of such divergences.

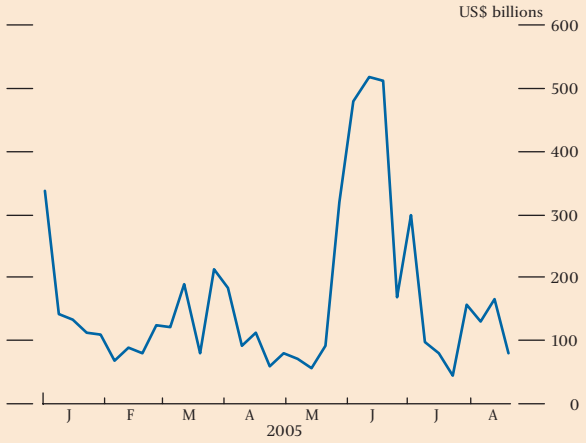
Specials trading and bond futures

In a repurchase agreement (repo) one party lends cash to another, who in turn delivers collateral (such as government bonds) as security for the term of the agreement. The rate at which cash is lent depends not only on the general level of interest rates, but also on the demand for the securities provided as collateral. For example, the holder of a bond that is in short supply may be able to borrow at favourable rates by offering the scarce bond as collateral. In this case, the bond is said to be 'trading special' in the repo market.

The seller of a bond futures contract undertakes to deliver one of a basket of bonds to the buyer during a particular month. The cost of delivering each of these bonds is approximately equalised through a conversion factor. But despite the conversion factor, the cost of delivering each of the bonds will not be the same, and one bond will be the 'cheapest to deliver' (CTD). This can cause very strong demand to borrow the CTD bond from sellers of futures contracts, and may often lead to it trading special in the repo market.

In recent months, large US Treasury futures positions relative to the available supply of the CTD bond in the repo market have led the bond to trade unusually special. In turn, this has increased the frequency of dealers failing to deliver the CTD bond in repo agreements, leading to an increase in the number of failed repo transactions (Chart A). The cost of failing to deliver a bond in the US market is approximately equivalent to borrowing the bond in exchange for lending cash at an interest rate of zero per cent. Indeed, there have been reports that some market participants have lent cash at negative interest rates in exchange for 'guaranteed delivery' of the bond.(1)

Chart A
US Treasury failures to deliver



Source: Federal Reserve Bank of New York.

In response to this, from December onwards, the Chicago Board of Trade has decided to limit the number of futures contracts that can be held by any one institution in the final ten days of the life of each contract. The US Treasury has also announced that it is examining the possibility of introducing a securities lending facility in order to alleviate pressure on repo markets.

Credit default swaps and cash credit spreads

A credit default swap (CDS) allows investors to separate and transfer the credit risk on a particular reference entity, such as a company or sovereign. The buyer of the CDS is said to buy credit protection and has a similar credit risk position to selling a bond short. The seller of the swap is said to sell protection and has a similar credit risk position to owning a bond.

While a company's CDS price should be closely related to the credit spread on its bonds, several

(1) The December 2003 *Financial Stability Review* discusses another instance of increased repo settlement fails, in 2003, while Fleming and Garbade (FRBNY Current Issues, Vol. 10, No. 5) discuss the associated occurrences of negative repo rates.

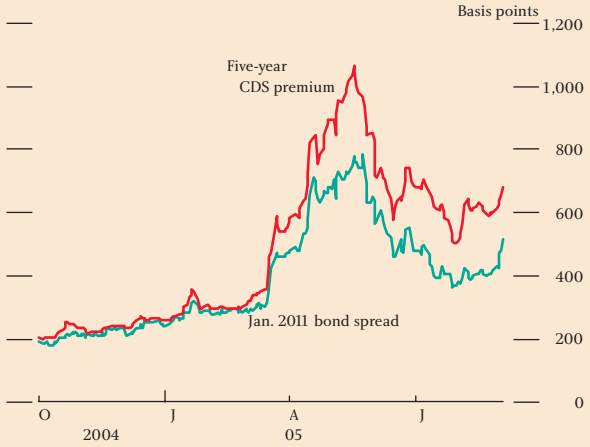
factors may cause the two to diverge.(2) One such factor is the balance of supply and demand in the CDS market. For example, at times, recent high investor demand for synthetic collateralised debt obligation (CDO) tranches may have contributed to a narrowing in the difference (or 'basis') between CDS spreads and bond spreads. This is because dealers that sell these credit portfolio products (ie buy credit protection) may hedge their positions by selling credit protection in the single-name CDS market.

Typically, the CDS spread exceeds the cash spread by a small amount. One reason for this is that an investor seeking to take a negative view of a company's credit prospects can do so either by selling its bonds short or buying protection using CDS. But because the supply of bonds is limited, it may be expensive (or even impossible) to borrow the bond in order to cover the short position. This may lead investors to buy credit protection in the CDS market rather than attempting to short the company's bonds, so widening the CDS-bond basis.

If demand to take a negative view on a company's credit standing suddenly increases, the difference between bond and CDS spreads can widen sharply. A recent illustration of such a divergence occurred following the ratings downgrades of GM and Ford. Early this year, the basis between five-year GM CDS spreads and spreads on GM bonds of a similar maturity had been, as usual, slightly positive. GM released a profit warning in March, prompting speculation that its credit rating would be downgraded to sub-investment grade. Indeed, S&P did downgrade GM and Ford as well as their financing subsidiaries to sub-investment grade in May.

Both the bond spread and the CDS spread widened significantly in response to the news (Chart B). But the reaction was much greater in the CDS market, with the CDS-bond basis rising to around 300 basis points in mid-May (Chart C). This rise in the basis could be attributed to investors finding it easier to take a negative view of GM's prospects in the CDS market than in the bond market, where it was expensive to borrow bonds in order to sell them short

Chart B
GM bond spread and credit default swap premium



Sources: Mark-it Partners, Merrill Lynch and Bank of England calculations.

Chart C
GM bond-CDS 'basis'(a)

Sources: Mark-it Partners, Merrill Lynch and Bank of England calculations.

(a) Difference between five-year CDS premium and credit spread on Jan. 2011 bond.

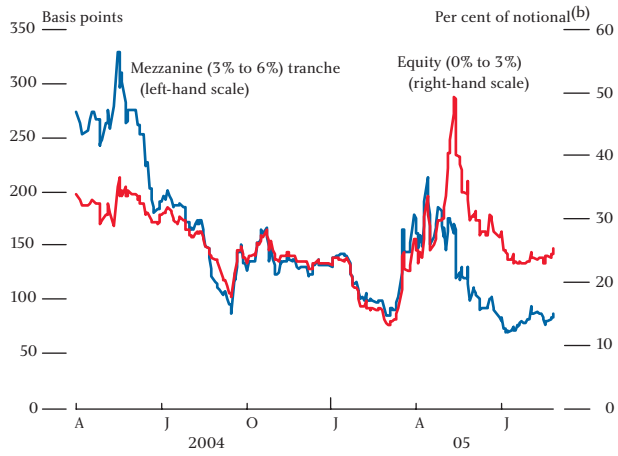
(that is, the bonds were trading special). Once GM's spreads began to decline in late May and June, much of the increase in the CDS-bond basis unwound sharply, perhaps indicating a high number of speculative positions in the CDS market. There were similar, although somewhat less marked, movements in Ford's CDS-bond basis.

Summary

These examples demonstrate that it is sometimes important to consider developments in both cash and derivative markets when interpreting asset price developments. Divergences between cash and derivative market prices may also give clues about market dynamics and the trading strategies of different groups of investors.

(2) Some of these factors are discussed on pages 130–32 of Rule, D (2001), 'The credit derivatives market: its development and possible implications for financial stability', *Financial Stability Review*, June.

Chart 33
Equity and mezzanine tranche spreads of European CDS index(a)



Source: JPMorgan Chase and Co.

(a) Five-year on-the-run iTraxx Europe investment-grade index.
(b) Equity tranches are quoted as an upfront price (a per cent of the notional transaction size). A higher price for credit protection indicates an increase in tranche risk, so the upfront price acts like a spread.

during the May credit stress, appeared to re-open, with issuers tapping the market with innovative PIK products.

The structured credit market also appears to have recovered quickly from the May episode (Chart 33). Tranche spreads have narrowed, and the speed of price recovery is consistent with the disturbance having been confined to a relatively small number of dealers and investors.

Risk appetite and the search for yield

Taken together, the rise in global equities, the narrowing in credit spreads, and the continued low levels of market volatility suggest that the May credit stress has not dented investors' appetite to take risk.

In part, this could be a natural response to a fall in the general price of risk, driven by a reduction in uncertainty surrounding the macroeconomic environment. More specifically, low and stable inflation, less volatile output growth, less fragile corporate and financial balance sheets in industrial countries, and stronger national balance sheets in many emerging market economies may all have contributed to a fall in required risk premia (see the box on pages 308–09).

But the low price of risk may also reflect some degree of mispricing by investors. In particular, some investors may have underestimated new channels for contagion created by innovative financial instruments. Alternatively, they may have unrealistic expectations about the ability of macroeconomic policy makers to offset shocks in the economy. If a mispricing has occurred, the eventual correction in the price of risk could pose a threat to the wider financial system.

Recent issues of the Bank's *Financial Stability Review* have identified two adjustment mechanisms that could possibly have implications for the financial system. First, credit problems may build up gradually if a sustained mispricing of credit risk results in an over-accumulation of debt. Second, it is possible that, at some point, there could be an asset price correction in fixed-income markets, which might spill over to other parts of the system, potentially straining market liquidity.

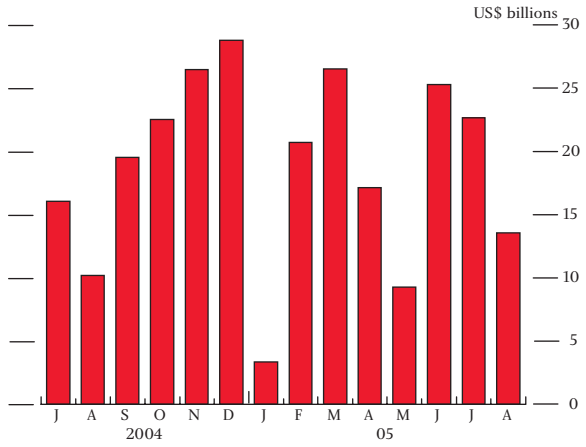
Despite the period of credit market stress in May, it is not obvious that the risks associated with these possible adjustment mechanisms have become any less significant, as many of the factors characterising the 'search for yield' remain intact. Against the background of continuing global low real interest rates and plentiful liquidity in financial markets, investors seem to have continued to seek out new investments to generate higher returns, often through increased leverage. This is most evident in the continued strength in credit markets. In the leveraged loan market, spreads have fallen, covenants and collateral requirements are reported to have been loosened and leverage multiples to have risen.

Likewise, underlying demand from continental European and Asian financial institutions to take risk on collateralised debt obligations (CDOs) — the so-called 'structured credit bid' — has remained strong. This has been an important manifestation of the search for yield because asset purchases by leveraged CDO vehicles have contributed to the downward pressure on credit spreads across a range of credit instruments in recent years, including CDS, asset-backed securities and leveraged loans.

There has reportedly been some reduction in demand for the most complex structured products such as mezzanine tranches of CDO-squared. But overall issuance volumes do not suggest a desire to take less risk (Chart 34). Rather, the strategies used to generate a 'mezzanine-like' return may have changed.

For example, market commentators report that investors who had typically bought mezzanine credit risk have

Chart 34
Global funded CDO issuance



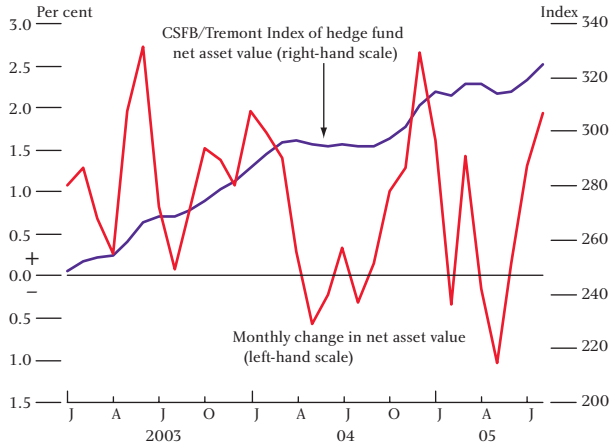
Source: JPMorgan Chase and Co.

taken leveraged exposure to super-senior tranches(1) of CDOs and CDS indices, or taking equity tranche exposure via credit constant proportion portfolio insurance (CPPI) transactions.(2) So investors may have reacted to the rise in the relative price of mezzanine tranches (ie the fall in implied correlation) in May by seeking better returns through structures that offer leveraged exposures to the most senior parts of the capital structure and deleveraged exposures to the most junior. Some dealers may also have seen such structures as a way of reducing their exposure to changes in implied credit correlation: rather than taking 'long equity, short mezzanine' positions themselves (the trade that had suffered unexpectedly high losses in May) or seeking to transfer such positions to hedge funds, they may have been looking to transfer the risk on more parts of the capital structure to end investors.

A continued search for yield has also been evident elsewhere. In particular, market contacts have noted significant growth in commodity-backed investments such as exchange-traded commodity funds. Market contacts have also remarked on strong capital inflows into local currency debt markets in countries like the Czech Republic and Poland. Similarly, a number of supranational agencies have recently issued debt in emerging market currencies (for example the Mexican peso and the Turkish lira) in response to strong investor demand.

In large part, the speculative community appears to have shrugged off the May disturbance; flows into hedge funds remained robust in 2005 Q2, despite some funds suffering relatively poor returns in May. Redemptions were said to have been smaller than was feared at the end of June. And, in aggregate, hedge funds posted positive returns in the second quarter (Chart 35).

Chart 35
Hedge fund performance



Sources: CSFB/Tremont and Bank of England calculations.

In summary, for a short period in the late spring, market rumours about potential scaling-back of positions had led some market participants to believe the initial disturbance might prompt a more general correction in asset prices. In the event, financial markets seem to have come through the May disturbance relatively unscathed. This may have been because the disruption in May was contained within a small number of dealers and hedge funds, and did not spill over to the wider group of investors. Moreover, the disturbance was not strong or widespread enough to generate significant and damaging concerns about counterparty credit risk. In this respect, there remains the possibility that a more significant shock could trigger a more sustained and general asset price correction. Drawing on market intelligence from its contacts, the Bank will continue to monitor developments and report them in future editions of the *Quarterly Bulletin* and *Financial Stability Review*.

Developments in market structure

London bombings

On the morning of 7 July 2005, there were four explosions on public transport in Central London. This

(1) Tranches of CDOs that are above AAA-rated tranches in the capital structure are called 'super-senior' tranches. The likelihood of a super-senior tranche suffering default losses are remote and so they typically earn only a very small spread.
(2) CPPI structures are a variant of portfolio insurance: funds are typically allocated between risk-free and risky assets (in this case, structured credit products). When the risky assets are performing well, more funds are allocated to them. Conversely, when they are performing less well, more funds are held in risk-free with the aim of protecting overall returns.

was followed by a further four attempted bombings on 21 July 2005.

In addition to the London Clearing House, one other financial institution evacuated its offices on 7 July but continued trading from contingency locations. Some banks also decided to switch trading temporarily to other centres. And some infrastructure providers made amendments to their normal operations. However, the majority of institutions followed official advice that staff should stay inside their offices, and continued business as normal, especially once some of the uncertainty about the nature of events had subsided.

The sterling payment systems operated without interruption; the Bank was able to conduct its routine operations without problems. The only small change was that the Bank provided all the funds needed by the market at 12.15, following the MPC announcement that day, rather than holding back at least £200 million until its 14.30 round of operations, as it would normally. This was a response to information from the Bank's counterparties that market participants were seeking to square off positions earlier in the day than normal.

The Tripartite Authorities (HMT, FSA, and the Bank) received input from participants and infrastructure providers via a conference call of a cross market group. The Bank also consulted members of the Money Market Liaison Group and chaired conference calls of the Foreign Exchange Joint Standing Committee (FXJSC) and FXJSC Operations subgroup.

One business continuity service provider reported 28 invocation calls and 84 stand-by requests following the 7 July bombings. But by 11 July all firms had returned to their usual arrangements.

Credit derivative confirmations and assignments

Since 2001, the Bank's *Financial Stability Review* has noted the rapid growth in credit derivatives trading and questioned whether back offices were coping effectively with the associated increase in trade processing volumes. Over the current review period, more users, including many hedge funds, have signed up to the Depository Trust and Clearing Corporation's (DTCC's) matching system, which has become a popular vehicle to tackle the confirmations backlog. DTCC was reported to have around 20 dealers participating in its system and signed its 100th end-user (many of which are hedge funds) over the review period. Also, a new platform, known as T-zero, was launched by Creditex. It aims to introduce electronic capture and straight-through processing of CDS trades from various front-office trading methods (voice brokered, electronic, telephone) with same-day electronic confirmation.

A related issue is that of assignments (typically where a hedge funds assigns a derivatives transaction with one dealer to another dealer, so that the original dealer now has a trade with the new dealer). Assigning trades to third parties without informing the original dealer could potentially impede effective risk management in stressed conditions.(1) To address this, the International Swaps and Derivatives Association (ISDA) has published a protocol designed to make it easier for the original dealer to give its consent.(2) Obtaining consent is important to ensure that the assignment is legally robust and therefore that the parties involved are certain about their market and counterparty credit risk exposures.

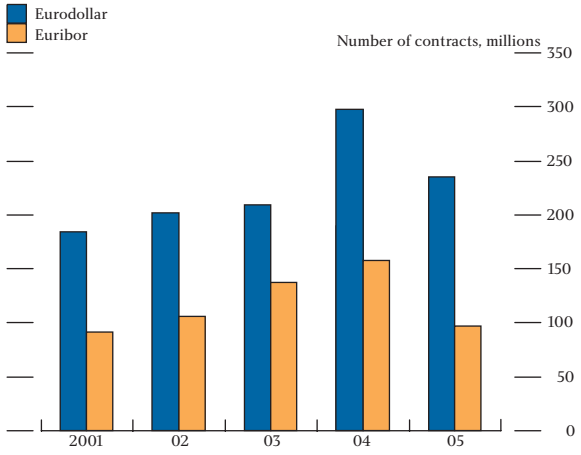
Exchange-traded futures markets

Trading volumes of short-term interest rate futures contracts have risen rapidly over recent years (Chart 36). For example, volumes of Eurodollar futures contracts traded on the Chicago Mercantile Exchange (CME) from January to July 2005 were around 40% higher than the equivalent period in 2004. Contacts say that this growth is mainly due to the shift towards electronic trading, which has reduced risks and lowered trading costs. In July, around 85% of Eurodollar futures were traded electronically, involving mainly shorter-term, more liquid contracts. Longer-term contracts on the CME are still pit-traded as are most Eurodollar options.

Electronic trading may also have contributed to rapid growth in trading volumes via increased activity of traders in 'arcades' (although arcade traders typically take only intraday positions). Arcades are vehicles that typically provide trading facilities and a legal, risk management and physical structure in return for a share of trading profits.

(1) For more details, see the speech by Paul Tucker, the Bank's Executive Director for Markets, available at www.bankofengland.co.uk/publications/speeches/2005/speech251.pdf.
(2) See www.isda.org/2005novationprot/2005novationprot.html.

Chart 36
Eurodollar and Euribor futures volumes(a)



Sources: CME and Euronext.liffe.

(a) 2005 data covers the January to July period.

As noted in the Summer *Quarterly Bulletin*, trading volumes of short sterling futures and options have also been increasing sharply. Contacts suggest that the increase in global trading of short-term interest rate expectations in part reflects increased activity of fixed income and macro hedge funds.

Removal of bankers' acceptances from the Bank's eligible collateral list

Bankers' acceptances ceased to be eligible for Bank of England money market operations on 17 August 2005, following a six-month transition period. The change had been announced on 11 February 2005. The use of eligible bankers' acceptances in the operations had declined to the point where they formed an insignificant part of the Bank's overall collateral pool. Bills of exchange, including bankers' acceptances, had historically played an important part in the short-term financing of some firms. In recent years, however, and as discussed in previous *Quarterly Bulletins*, the role of bill finance had declined markedly as firms developed other sources of borrowing. By late 2004, the size of the eligible acceptance market had fallen below £1 billion compared with £18 billion in 1998.

Long-dated bond issues

The US Treasury announced in its 3 August Quarterly Refunding Statement its intention to re-issue a 30-year bond from 2006 Q1; the size of the issuance was unspecified. In addition, the United Kingdom's Debt Management Office (DMO) announced that it will issue the first ultra-long index-linked gilt, maturing on 22 November 2055, by means of a syndicated offering rather than an auction (although the DMO will revert to the use of auctions for subsequent issuance of ultra-long gilts). It will also be the first index-linked gilt to use a three-month indexation lag.

Bank of England official operations

Changes in the Bank of England balance sheet

The size of the sterling components of the Bank's balance sheet increased slightly, reflecting a rise in banknotes issued and a corresponding increase in the stock of financing via open market operations (OMOs) (Table B). Other elements of the Bank's balance sheet — including the sterling value of the foreign-currency components — changed little. Notes in circulation fluctuated with seasonal and weekly variation in demand for banknotes (Chart 37).

The Bank purchased gilts over the period in accordance with its published screen announcements; £31.4 million of 4¾% 2015 in June, £31.4 million of 5% 2010 in July and £31.4 million of 5% 2012 in August. A screen announcement on 1 September 2005 detailed the purchases to be made over the following three months.

The Bank maintained the value of its three and six-month euro-denominated bills outstanding at €3.6 billion, issuing new bills on a monthly basis as old bills matured. The average indicative spread to Euribor

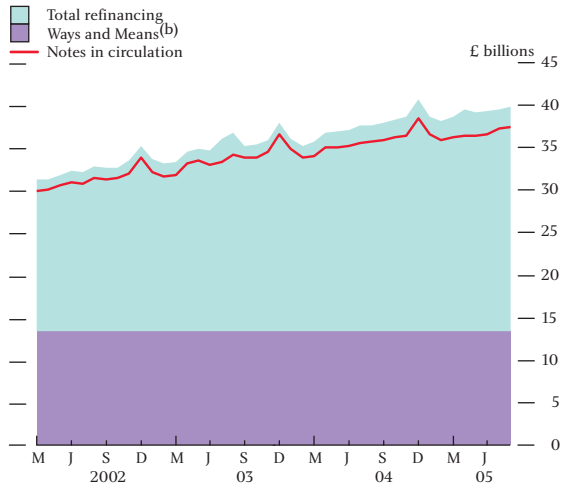
Table B
Simplified version of Bank of England consolidated(a) **balance sheet**(b)

£ billions

Liabilities	2 Sep.	27 May	Assets	2 Sep.	27 May
Banknote issue	41	39	Stock of refinancing	30	28
Settlement bank balances	<0.1	<0.1	Ways and Means advance	13	13
Other sterling deposits, cash ratio deposits and the Bank of England's capital and reserves	9	9	Other sterling-denominated assets	4	4
Foreign currency denominated liabilities	14	15	Foreign currency denominated assets	17	18
Total(c)	**64**	**63**	**Total**(c)	**64**	**63**

(a) For accounting purposes the Bank of England's balance sheet is divided into two accounting entities: Issue Department and Banking Department. See 'Components of the Bank of England's balance sheet' (2003), *Bank of England Quarterly Bulletin*, Spring, page 18.
(b) Based on published weekly Bank Returns. The Bank also uses currency, foreign exchange and interest rate swaps to hedge and manage currency and non-sterling interest rate exposures — see the Bank's 2003 *Annual Report*, pages 53 and 73–79 for a description.
(c) Figures may not sum to totals due to rounding.

Chart 37
Banknotes in circulation, the stock of OMO refinancing, and 'Ways and Means'(a)

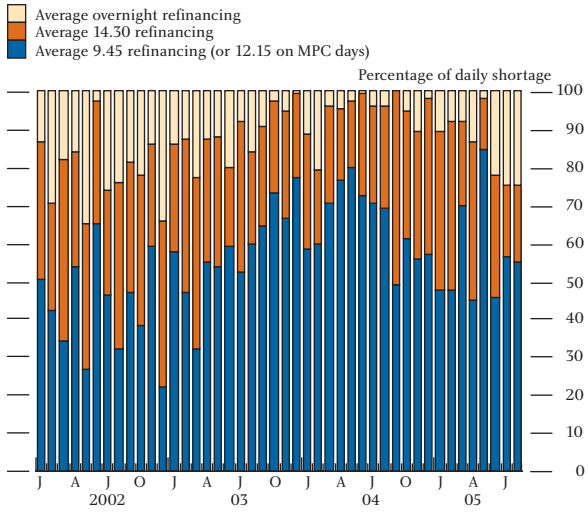


(a) Monthly averages.
(b) An illiquid advance to HM Government. This fluctuated prior to the transfer of responsibility for UK central government cash management to the UK Debt Management Office in April 2000. The Ways and Means is now usually constant.

of three-month issuance narrowed to 9.5 basis points below Euribor, compared with 10.0 basis points over the previous review period; for six-month bills, the average issuance spread narrowed slightly to 10.6 basis points below Euribor from 10.7 basis points. The total nominal value of Bank euro notes outstanding remained at €6 billion.

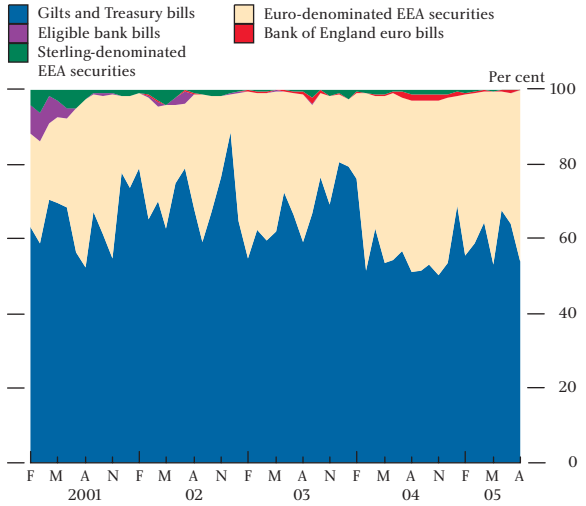
In the Bank's daily OMOs in the sterling money markets, the amount of overnight financing through late lending increased over the period with an equivalent reduction in two-week financing through the earlier rounds of operations (Chart 38). In part, this may have reflected

Chart 38
Refinancing provided in the Bank's open market operations(a)



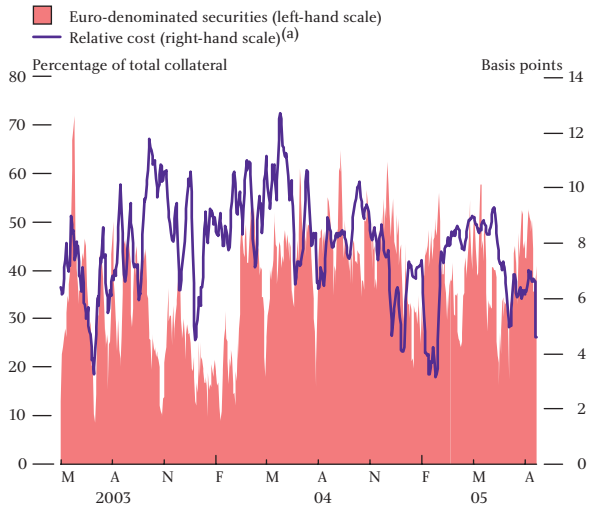
(a) Monthly averages.

Chart 39
Instruments used as OMO collateral(a)



(a) Monthly averages.

Chart 40
Relative cost and use in OMOs of euro-denominated EEA government securities



(a) Relative cost calculated as the difference between one-month BBA repo and Libor fixing spread and one-month European Banking Federation repo and Euribor spread. A wider spread indicates a lower cost of repoing euro-denominated debt relative to repoing gilts.

the reduction in the spread charged on the Bank's overnight lending facilities from 100 to 25 basis points above the MPC official rate, as part of the interim money market reforms that took effect on 14 March.

On 25 July, the Bank aligned the list of collateral eligible for intraday credit in its sterling real-time gross settlement (RTGS) payment system with the list of collateral eligible for liquidity in its OMOs. This change had been formally announced to all members of the RTGS service on 22 April. Following the change, the RTGS and OMO lists comprise sterling and euro-denominated securities issued by EEA central governments, central banks and certain international

organisations. The Bank also requires issuers of these bonds to be rated Aa3 (on the Moody's scale) or higher by two or more of the Moody's, Standard & Poors, and Fitch rating agencies.

On average, the use of euro-denominated collateral by counterparties participating in the Bank's OMOs decreased slightly over the period (Chart 39), in line with an increase in its average relative cost (Chart 40).

Short-dated interest rates

The primary objective of the Bank's operations in the sterling money markets is for overnight market interest rates to be in line with the MPC's official rate, so that there is a flat money market yield curve out to the next MPC decision date, with very limited day-to-day or intraday volatility in market interest rates out to that horizon.

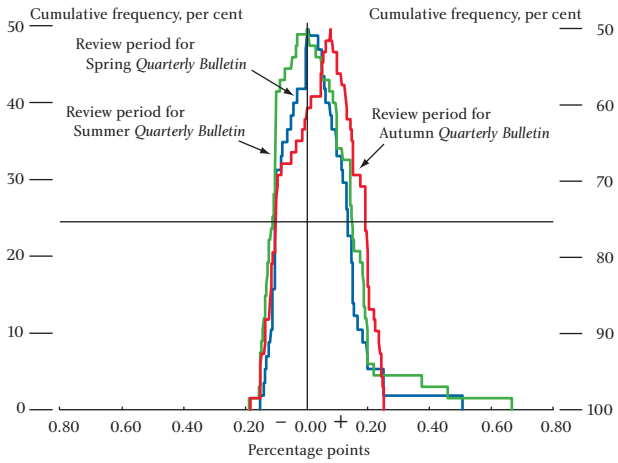
The distribution of the spread between the sterling secured (gilt GC repo) overnight rate and the official Bank repo rate has narrowed in the most recent review period (Chart 41). This is the first full review period since the introduction of interim reforms to the Bank's operations in the sterling money markets, which included a narrowing of the interest rate 'corridor' on the Bank's overnight lending and deposit facilities to +/- 25 basis points from +/- 100 basis points.

The package of interim reforms also introduced indexing of the rate charged on the Bank's daily two-week repos to the official interest rate. One aim of indexing was to eliminate so-called 'pivoting' ahead of MPC meetings. Pivoting had caused a perverse rise in the relevant overnight rate in the run-up to MPC meetings at which the official rate was expected to be cut, and *vice versa*. It was previously observed ahead of the June and August 2004 MPC meetings.(1)

Indexing appeared to eliminate 'pivoting' successfully ahead of the August MPC meeting, when market participants were widely expecting a reduction in the official rate. The average spread between the highest and lowest sterling overnight market interest rate traded each day has narrowed and peaks in the overnight rate have been significantly lower since the interim reforms took effect (Chart 42).

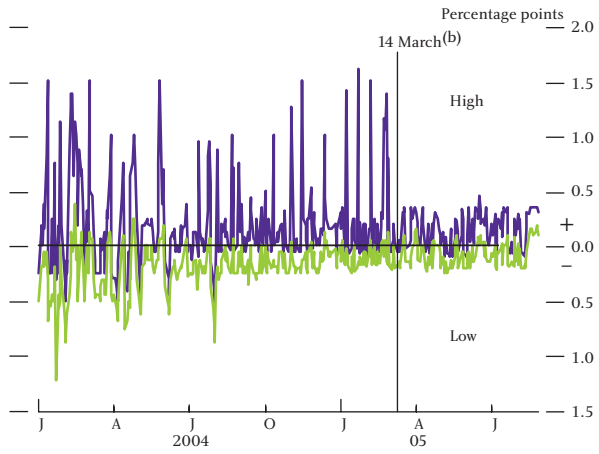
Overnight market rates were closer to the official rate over the review period than in recent years (Chart 43).

Chart 41
Cumulative folded distribution of sterling secured overnight rates(a)



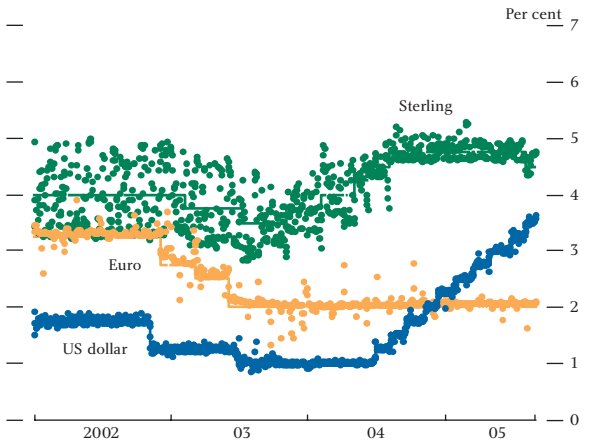
(a) Distribution of the spread between the GC repo rate and the official rate. A negative spread indicates that the market rate is less than the official rate; if more than 50% of the spread distribution is below zero, it has a negative bias.

Chart 42
Volatility of the sterling overnight interest rate(a)



(a) High and low of the day observed by the Bank's dealing desk as a spread to the policy rate.
(b) On 14 March, the Bank implemented interim reforms to its operations in the sterling money markets.

Chart 43
Overnight interest rates and policy rates



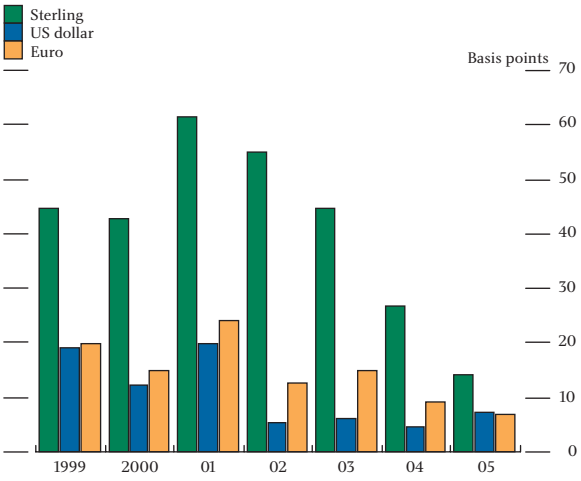
Sources: Bank of England and Bloomberg.

(1) Pivoting is described on page 129 of the Summer 2004 *Quarterly Bulletin*.

They were still slightly more volatile than comparable dollar and euro rates, but the difference has narrowed markedly over the past year (Chart 44). The Bank's full money market reforms are intended to reduce volatility further.

A wide range of counterparties continued to participate in the Bank's OMOs and there was a small further decrease in the concentration of the stock of financing (implying more counterparties were participating in operations) over the period (Chart 45).

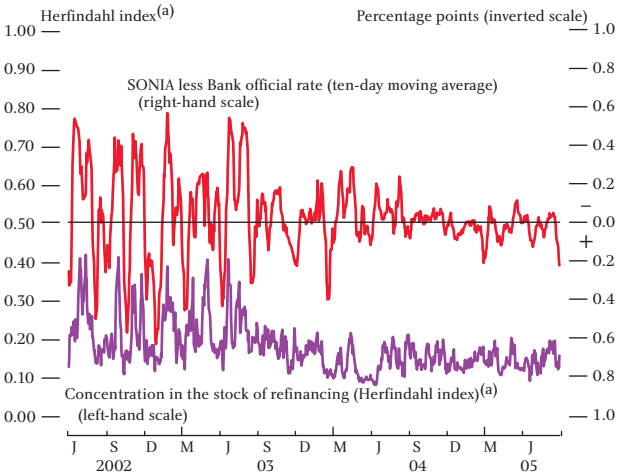
Chart 44
Standard deviation of difference between official interest rates and overnight interest rates(a)



Sources: Bloomberg and Bank of England calculations.

(a) Overnight interest rates are SONIA for sterling, the Fed funds rate for US dollar and EONIA for euro.

Chart 45
SONIA relative to the Bank official rate and concentration in the stock of OMO refinancing



(a) The Herfindahl index is calculated by squaring the share of refinancing held by each counterparty and then summing the resulting numbers. An index of one implies a single counterparty accounted for the entire stock of refinancing ie high concentration. As the index approaches zero, concentration falls.

Forecasting the liquidity shortage

The average accuracy of the Bank's liquidity forecast remained broadly similar to previous quarters (Table C).

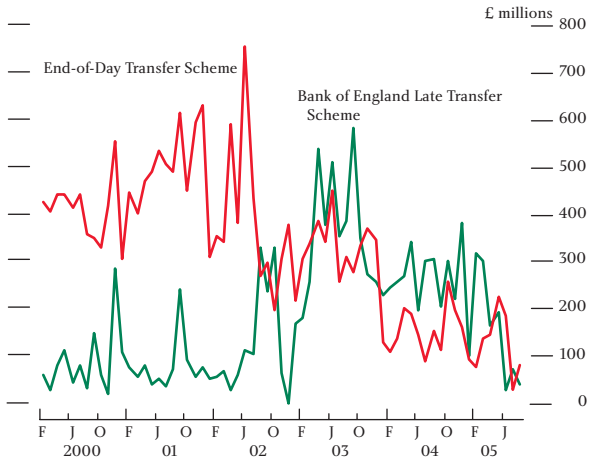
Over recent months, flows in the end-of-day schemes for settlement banks have fallen. Average payments in both the Bank of England Late Transfer Scheme (BELTS) and End-of-Day Transfer Scheme (EoDTS) decreased over the period (Chart 46). This could be because fewer flows are occurring late in the day so the clearing banks are able to make more accurate forecasts of their end-of-day positions — over a longer horizon, the clearing banks attribute some of the observed decline to less uncertainty about the end-of-day positions following the merger of CMO into CREST in October 2003. EoDTS and BELTS will cease after the full range of money market reforms are introduced.

Table C
Intraday forecasts versus actual liquidity shortages

Mean absolute difference (standard deviation), £ millions

	9.45 forecast	14.30 forecast	16.20 forecast
2002	83 (107)	43 (79)	30 (73)
2003	101 (123)	61 (96)	51 (85)
2004 Q1	120 (108)	79 (77)	55 (43)
2004 Q2	115 (123)	58 (78)	61 (74)
2004 Q3	89 (69)	62 (44)	52 (32)
2004 Q4	107 (115)	69 (78)	57 (63)
2005 Q1	117 (121)	87 (101)	63 (77)
2005 Q2	122 (111)	67 (95)	62 (95)
July-2 September	113 (97)	56 (45)	54 (45)

Chart 46
Bank of England Late Transfer Scheme and End-of-Day Transfer Scheme(a)



(a) Monthly averages.

Progress on money market reform

A consultative paper on transitional arrangements(1) to the reformed system was published in August. In

(1) Available at www.bankofengland.co.uk/markets/moneymarketreform/transarrang050823.pdf.

particular, it contained proposals for repo lending by the Bank at longer maturities (of six to twelve months).

The draft legal and operational documentation(1) for the reformed system was published in July. The final version of the documentation will be published later in the year, together with a timetable for submitting applications to participate in the new system.

The levels of interest in participating in the new system are encouraging. Around 40–50 eligible(2) banks and building societies are planning to become reserve scheme members and around 50–60 are planning to have access to the Bank's standing facilities.

The Bank's own preparations are progressing well. Development of all the main IT systems (ie accounting, collateral management, reserves and liquidity forecasting systems) has now been completed and they have gone into trialling.

The Bank continues to expect the new system to be launched during the period March to June 2006. As noted in the box on pages 324–25, discussions at the Money Market Liaison Group have indicated that most market participants appeared on-track for this timetable.

(1) Available at www.bankofengland.co.uk/markets/moneymarketreform/smmreform050722.pdf.
(2) Broadly, eligible banks comprise UK banks and building societies that have sufficient sterling eligible liabilities to be required to hold cash ratio deposits with the Bank.

The work of the money market liaison group

The money market liaison group (MMLG) was established in 1999 following a series of reforms to the sterling money markets. Typically, it meets quarterly and comprises representatives from market participants, trade associations and the authorities.

It provides a high-level forum for discussion of market or structural developments affecting sterling money markets and related infrastructure and, where appropriate, responses to them. The format of the meeting was altered this year to make a greater distinction between, on the one hand, the Bank communicating and consulting on developments in its official operations and, on the other hand, wider market issues. The latter includes regular reports from infrastructure providers, trade associations, the FSA and the DMO. Minutes of MMLG meetings are published on the Bank's website.

Discussion of developments in the Bank of England's official operations

Over the past year, the Bank has informed and, where appropriate, consulted the group on its proposals for money market reform and changes to the collateral taken in its operations.

Money market reform

The Bank has kept the group informed at each stage of the reform process. This has included the Bank's two market consultations on reform proposals in mid and late 2004, the subsequent introduction of interim reform measures in March 2005, the final decisions on the reformed framework in April, planning of the conference held by the Bank for prospective reserve account holders in April, and progress on the preparations for the launch of the new framework.

Collateral taken in the Bank's official operations

The group was informed of two significant changes to the Bank's collateral arrangements over the past year. First, the Bank introduced collateral concentration limits such that its counterparties and settlement banks now need to ensure that the securities of a single issuer (other than the UK government and the Bank of England) comprise no more than 25% of the total collateral that they repo to the Bank in open market operations and for intraday liquidity in the RTGS payment system. The Bank explained at the September 2004 MMLG meeting that the decision was motivated by risk management and was a response to the gradual shift in the collateral received by the Bank towards euro-denominated paper, with an increasing share issued by a small number of governments.

Second, the Bank aligned the collateral lists for its open market operations and for intraday RTGS liquidity. The Bank explained to the MMLG that collateral taken intraday should have the same credit standards as collateral taken against term lending as the Bank might have to extend intraday liquidity overnight — for example, following disruption to payment and settlement systems.

Discussions/initiatives relating to wider issues for the sterling money market

Wider market issues discussed by the group over the past year have included:

Decision-taking in the sterling money markets in a crisis: responsibilities and process

In the event of a crisis in the sterling money market, the MMLG has a twin co-ordinating role: to provide a means of communication using conference call arrangements; and, if required,

to make recommendations on trading or market conventions. The MMLG has been agreeing a table showing how decision making would work in a crisis, setting out the respective roles of the Bank, CRESTCo, CHAPSCo and MMLG. This table will be published on the Bank's website shortly.

Guidance on the timetable for the allocation of ISINs to CD issues in CREST

A timetable was drawn up following work by a MMLG subgroup and posted on the MMLG website.(1) The stated aim is to ensure that ISINs are issued within one hour of trading unless otherwise agreed by the issuer and investor.

Change from brokers quoting short-dated interest rates in fractions to decimals

One of the aims of the MMLG is to identify and address areas where the functioning of the sterling money market could be improved. In a discussion at a MMLG meeting a year ago, there was widespread agreement that it would be sensible for market participants to switch the quoting and trading of short-dated sterling interest rates from fractions to decimals in the interest of modernising the market. This switch subsequently took place from the start of 2005.

Discussions about sterling short-term interest rate futures

At recent meetings, MMLG has discussed the cases for introducing a sterling overnight interest rate (SONIA) swap future and for reducing the tick size for the existing short sterling futures contract on LIFFE. The LIFFE representative on the group reported at the June meeting that consultation with interested parties had revealed that these proposals did not have the support of sufficient market participants.

Other issues

Other topics raised by members at recent MMLG meetings have included: the London Clearing House's plans to add gilt delivery-by-value (DBV) repo transactions to its existing gilt repo clearing service; plans for the future CREST/Euroclear single settlement platform; the timing of the sterling overnight interest rate average (SONIA) fixing; and proposed compensation arrangements for failed payments in sterling being developed by the APACS Liquidity Managers Group.

(1) www.bankofengland.co.uk/markets/money/smmlg.htm.

Assessing the MPC's fan charts

By Rob Elder of the Bank's Inflation Report and Bulletin Division, George Kapetanios of the Bank's Conjunctural Assessment and Projections Division and Tim Taylor and Tony Yates of the Bank's Monetary Assessment and Strategy Division.

The MPC places considerable weight on its economic forecasts when setting monetary policy. But there is inevitably uncertainty around the outlook for the economy, and to communicate this, the MPC publishes its projections as fan charts. This article discusses some of the issues that must be taken into account when assessing those fan charts, it reports a range of formal and informal tests of various aspects of the MPC's fan charts, and it discusses developments in the economy that may have pushed outturns away from the MPC's central projections. With only six years of fan chart projections that can be compared with outturns, the sample is too small to draw strong conclusions. But to date, at most forecast horizons, inflation and output growth outcomes have been dispersed broadly in line with the MPC's fan chart bands. That suggests that the fan charts gave a reasonably good guide to the probabilities and risks facing the MPC.

Introduction

The Monetary Policy Committee (MPC) was created by the Government in May 1997 to set interest rates for the United Kingdom. Between May 1997 and December 2003, the MPC's target was to stabilise RPIX inflation at 2.5%. Since then its target has been for CPI inflation to be 2%. There is typically a lag between changing interest rates and affecting the economy. The Committee therefore places considerable weight on the outlook for GDP growth and inflation,(1) and each quarter the MPC publishes its forecasts for growth and inflation in the *Inflation Report*.

Each quarter, the MPC assesses the extent to which its previous forecast appears to be on track. So an evaluation of short-term forecast performance is an integral part of the forecast process. And each year the MPC publishes a box in the August *Inflation Report* that assesses its forecasting record by reporting various measures of forecast accuracy. From time to time, external commentators have also made assessments of the MPC's forecasting performance. Recent examples include Pagan (2003) in a report commissioned by the Bank of England Court, the House of Lords Select Committee on Economic Affairs (2004), Wallis (2004) and Allen and Mills (2005).

This article expands on the analysis behind the boxes in the *Inflation Report* by considering a wider range of tests of forecast accuracy; looking at specific reasons that may have caused outturns to differ from the MPC's central projections at particular times; and reporting how the MPC has adapted its views in the light of those developments.

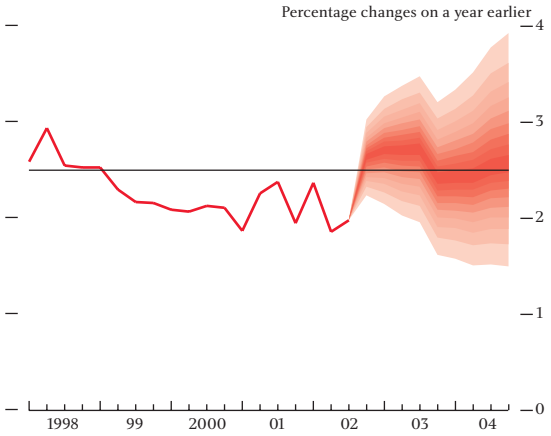
The fan charts

The MPC publishes its forecasts of inflation and output growth as probability distributions — so-called 'fan charts' — rather than as single point forecasts. The fans emphasise the inevitable uncertainty around the outlook for the economy. That could reflect uncertainty about the future economic environment: for example the outlook for world GDP, the sterling exchange rate, and other asset prices. It could also reflect uncertainty about the structure of the UK economy: for example, on the sensitivity of consumption to house price inflation or of consumer price inflation to demand growth.

Chart 1 shows an example of a fan chart for RPIX inflation. Fan charts depict the MPC's judgement of the probability of various outcomes for RPIX inflation in the future. The bands should be interpreted as follows: if economic circumstances at the start of the fan chart

(1) See Bean and Jenkinson (2001) and also the box on page 67 of the November 2000 *Inflation Report*.

Chart 1
An example of an RPIX fan chart



were to prevail on 100 occasions, inflation over the subsequent two years would be expected to lie within the darkest central band on only 10 of those occasions. Outturns of inflation are also expected to lie within each pair of the lighter red areas on 10 occasions. Consequently, inflation is expected to lie somewhere within the entire fan chart on 90 out of 100 occasions. The bands widen as the time horizon is extended, indicating the increasing uncertainty about outcomes.(1)

The shape of a fan chart reflects three judgements by the MPC about the future path of inflation (or GDP):

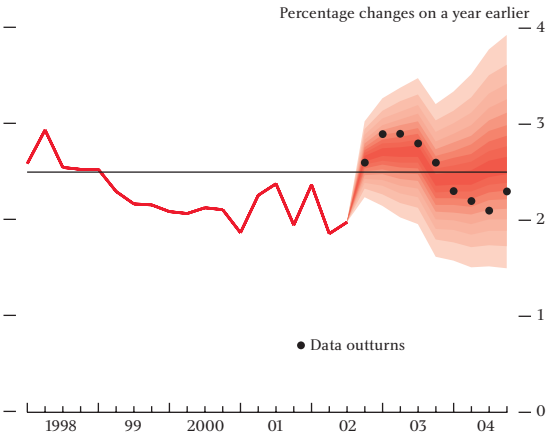
- The central projection, or the single most likely path (also called the mode(2)), which determines the profile of the central darkest band.
- The degree of uncertainty, which determines the width of the fan charts.
- And whether the fans are symmetrical or skewed, which determines the position of the mean,(2) relative to the central projection.

All of the assumptions underlying each fan chart are published on the Bank of England website.(3)

Assessing the fan charts: conceptual issues

To assess whether the MPC's fan charts have accurately described the uncertainty that it faced, we compare outturns against the probability bands (as in the example in Chart 2). By collecting this information from each fan chart, we can ask whether 10% of the outturns did actually lie in the fan chart central bands, and in each pair of outer bands.

Chart 2
Outturns relative to fan chart bands(a)



(a) The November 2002 fan chart assuming market interest rates.

The Committee publishes its fan chart projections under both the assumption of constant official interest rates and the assumption that official interest rates follow a path implied by market interest rates.(4) Sometimes, the two paths for interest rates will be similar. But when official interest rates are unusually high or low, the assumption that they will remain unchanged over the forecast period becomes less plausible. In those circumstances, assuming that interest rates follow the path implied by market expectations is likely to provide a more helpful benchmark, although there may be times when market participants hold a different view about economic prospects, and thus about the likely future course of interest rates, than the MPC. When assessing forecasting performance, it seems appropriate to focus on the fan chart based on the most plausible interest rate assumptions. So in this article, we focus on the fan charts based on the market expected path of interest rates.

There are some other important issues that must be borne in mind when considering tests of the fan charts. To date, for two year ahead projections, only 22 RPIX fan charts can be compared with data outturns (those published between February 1998 and May 2003).(5)

(1) See the box on pages 48–49 of the May 2002 *Inflation Report*, for a fuller description of the fan chart.
(2) See the box on page 332 for examples of the mode and the mean.
(3) www.bankofengland.co.uk/publications/inflationreport/irprobab.htm.
(4) See the box on pages 42–43 of the August 2004 *Inflation Report* for further discussion of this issue.
(5) This article uses RPIX data up to 2005 Q2 and GDP growth data from the 2005 *Blue Book* which goes up to 2005 Q1. So the most recent fan chart that can be compared with outturns two years ahead is from the May 2003 *Inflation Report*. The sample size is a little larger for shorter horizon forecasts. The MPC started forecasting CPI inflation in February 2004, but we do not cover CPI projections here, because to date there is not even one CPI fan chart that can be compared with outturns at the two year ahead forecast horizon.

Note that here, we do not attempt an assessment of CPI forecasts.

With such a small sample of fan charts, it is difficult to distinguish between forecasting ability and luck. Furthermore, those fan charts are not independent of one another because they overlap. Consider two projections that look two years ahead and are made one quarter apart. They will mostly cover the same time period, and so will largely be tested against the same outturns. That is likely to generate serially correlated results. If, for example, outturns were higher than the central projection from one fan chart, that would also be likely to be true of the other fan chart. As we discuss later in this article (see page 334), the combination of small samples and serial correlation can cause tests of forecasts to be misleading. So it is not wise to draw firm conclusions from informal tests (such as looking at charts), or even from more formal statistical tests, if they do not take these factors into account.

Assessing the fan charts: results

Informal analysis

Past *Inflation Report* boxes on the MPC's forecast record reported the frequency with which outturns fell in the central 30% and 50% bands of published fan charts (Table A). If the sample were large enough, and the fan charts accurately depicted the likely dispersion of outturns, then we would expect half of the outturns to lie in the central 50% bands, and 30% to lie in the central 30% bands. The actual proportions have been reasonably close to what was expected for GDP growth, with the exception that at two years ahead, a larger proportion of outturns fell in the central 50% bands (Table A). But for inflation, there were more outturns in the central bands than expected. So, this raises the question of whether the inflation fan charts might have been too wide.

Charts 3 and 4 depict similar information to Table A, on how outturns have compared with the fan chart probability bands. But the charts contain considerably more information than Table A, because they cover all forecast horizons, and all probability bands. Each dot represents a data outturn and its vertical position indicates which percentile of the fan chart it fell in at a given forecast horizon. If a dot is close to the 50th percentile line, then the outturn was close to the median projection (see the box on page 332 for a definition of the median). If a dot is above 95 or below 5, the outturn was a long way from the median and is likely to have fallen outside the visible 90% probability bands. If the MPC's fan charts have accurately depicted the true probabilities, and the samples were sufficiently large, we would expect the dots to be evenly dispersed

Table A
The dispersion of outturns relative to fan chart probability bands

	Number of outturns	Number in central 30% bands	Number in central 50% bands
RPIX inflation			
One year ahead	24	11 (46%)	15 (63%)
Two years ahead	22	8 (36%)	18 (82%)
Annual GDP growth			
One year ahead	25	8 (32%)	13 (52%)
Two years ahead	21	5 (24%)	15 (71%)

Chart 3
RPIX inflation outturns relative to fan chart probability distributions(a)

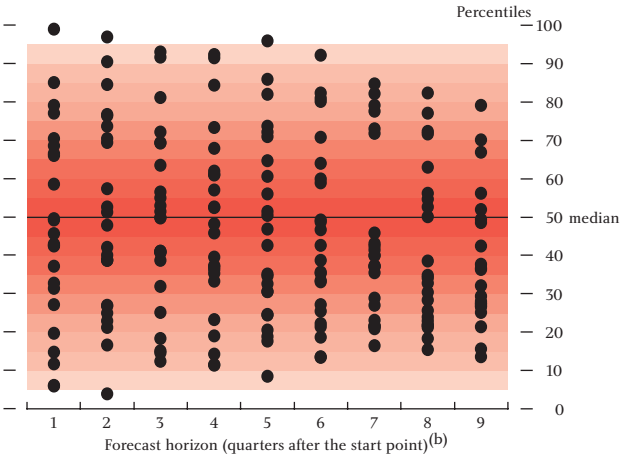
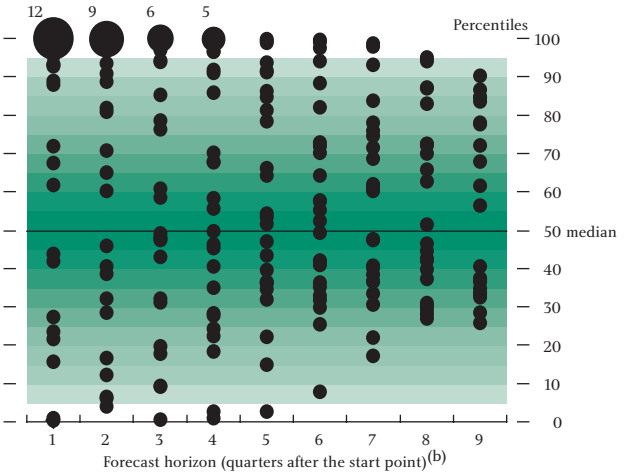


Chart 4
GDP outturns relative to fan chart probability distributions(a)(c)



(a) For forecasts made between February 1998 and November 2003 for RPIX and February 1998 to February 2005 for GDP.
(b) Data for the current quarter are not available when the forecast is made. So a 'one quarter ahead' forecast (horizon 1) is a forecast of the current quarter. For example the one quarter ahead forecast in August 2005 is for the outturn in 2005 Q3.
(c) For Chart 4, outturns at 1 to 4 quarters ahead, there are at least five outturns clustered above the 98th percentile in each case. These are shown by the larger dots in the chart; the numbers next to the dots indicate how many outturns there are.

vertically across all percentiles, for each forecast horizon.

A visual inspection suggests that in general the dots have been reasonably evenly dispersed at most forecast horizons. In broad terms, outturns have been evenly divided above and below the 50 line, with around 40% of RPIX outturns and 60% of GDP outturns above the median. This suggests that the MPC's central bands and skew have been reasonably accurate. But, for both RPIX and GDP fan charts, the dots appear clustered towards the centre for forecasts seven, eight and nine quarters ahead. That means outturns were less dispersed than the fan chart bands implied at long horizons. Furthermore, for GDP growth at short horizons, a large proportion of outturns were well above the median and clustered above the 90th percentile. That indicates both that the near-term central projections of GDP growth may have been too low, and that the fan charts may have been too narrow.

Formal statistical tests

We now turn to formal tests of the MPC's fan charts. These examine whether a set of data is likely to have been drawn from a specific distribution. The first test is a Kolmogorov-Smirnov (KS) test.(1) One problem with the KS test is that it is not very powerful in small samples. And it also takes no account of the degree of interdependence between observations. So the results must be treated with caution. The second test we use is an extension of a test first suggested by Berkowitz (2001). It is thought to be more powerful if the sample size is small, and it allows for dependence of forecast distributions over time. Nevertheless, the results must be treated with caution, as the adjustment for interdependence of fan charts is only an approximation of the expected time dependence. Appendix A describes the KS and Berkowitz tests in more detail.

Table B reports so-called 'p-values' from the two tests. They indicate how close the distribution of the outturns was to that implied by the fan charts. P-values lie between zero and one. The closer a p-value is to zero, the less likely it is that outturns were distributed in line with the fan charts. Following normal conventions, one can say with 95% confidence that there is significant evidence that the outturns were distributed differently to the fan charts if the p-values are 0.05 or below. In Table B, cells are not shaded when that is the case. But if the p-values are greater than 0.05 they are shaded orange. So shading indicates when there is not significant evidence against the fan charts. Throughout this article, when we report p-values, we have shaded them orange to indicate when the MPC's forecasts do not fail the specific test, at 95% confidence levels.

Table B
Density tests of the fan charts(a)

Horizon	RPIX		GDP	
	KS	Berkowitz	KS	Berkowitz
1	0.70	0.85	0.00	0.00
2	0.66	0.30	0.00	0.00
3	0.62	0.07	0.01	0.00
4	0.47	0.11	0.15	0.01
5	0.68	0.09	0.24	0.69
6	0.68	0.03	0.20	0.87
7	0.02	0.01	0.20	0.30
8	0.11	0.00	0.19	0.07
9	0.03	0.00	0.16	0.02

(a) For RPIX forecasts made between February 1998 and November 2003 and GDP forecasts made between February 1998 and February 2005. Numbers in the tables are p-values from the tests. Cells have been shaded where the p-value exceeds 5%.

The results in Table B are broadly consistent with the conclusions drawn from Charts 3 and 4. For horizons up to five quarters ahead, the distribution of RPIX outturns has been consistent with the fan charts, suggesting they have given a reasonable guide to eventual outturns.

But there is quite strong evidence that, for short horizon forecasts of GDP, the distribution of outturns was different to the fan chart distributions. In the section on GDP mean projections, we show evidence that the principal cause of the discrepancy between the short horizon GDP fan charts and the dispersion of outturns was the tendency for the published GDP data to be revised. As a result of this analysis, which was summarised in a box in the August 2005 *Inflation Report*,(2) the GDP fan charts have been widened at short horizons, which should mitigate this problem.

For long forecast horizons there is some indication that both GDP and RPIX outturns came from different distributions to the fan charts. That probably reflects outturns being more concentrated than implied by the width of the fan charts. This issue is discussed further in the next section.

Various researchers are exploring better ways to analyse forecasts of probability distributions. The tests we report here should not, therefore, be thought of as a final conclusive assessment. It is possible that different tests could generate quite different conclusions,

(1) For a textbook account of this test see Kendall and Stuart (1979).
(2) 'The MPC's forecasting record' on pages 40–41.

particularly if applied to different samples. But we take some comfort from the fact that the formal tests lead to similar conclusions as the informal analysis.

The formal tests are joint tests of the central projection, the degree of uncertainty and the skew. They do not distinguish between differences in distribution caused by the fan charts being too narrow, too wide, or centred around the wrong central profile. In the remainder of this article we focus on the individual assumptions underlying the fan charts. First, we consider the MPC's assessment of uncertainty, as the informal and formal tests of the fan charts suggest that the fan charts may have been too wide at long horizons. Then we turn to the MPC's projections of mean GDP growth and inflation.

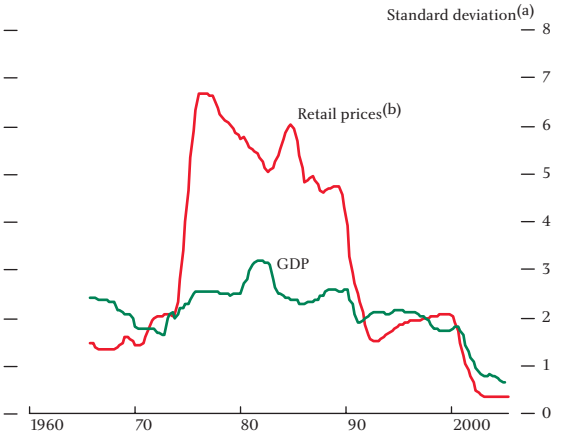
The width of the fan charts

The width of the fan charts depicts the MPC's assessment of the degree of uncertainty that it faces. Fan charts widen as the forecast period extends, reflecting the increased probability that some unforeseen event could push inflation or output growth away from the central projection. As a starting point, the width of the fan chart is based on the actual dispersion of outturns around the Bank of England/MPC forecasts over the preceding ten years. The MPC then judges whether uncertainty looking forward is likely to be greater or less than that past experience, and modifies the fan charts accordingly. As an example of such an adjustment, in February 2003 the MPC judged that the threat of a military conflict with Iraq added substantially to the risks facing the UK economy and so it temporarily widened the fan charts.

As discussed above, outturns between 2000 and 2005 tended to be closer to the MPC's two year ahead central projections than implied by the fan chart bands. Some commentators including Clements (2004), Mitchell and Hall (2005) and Wallis (2004) have highlighted this fact. Separately, Cogley *et al* (2004) generated a fan chart of UK inflation using different methods to those of the MPC. For a projection made in 2002 Q4, their fan chart was about half as wide as the equivalent chart of the MPC. So some commentators have suggested that the MPC's fan charts may have been too wide.

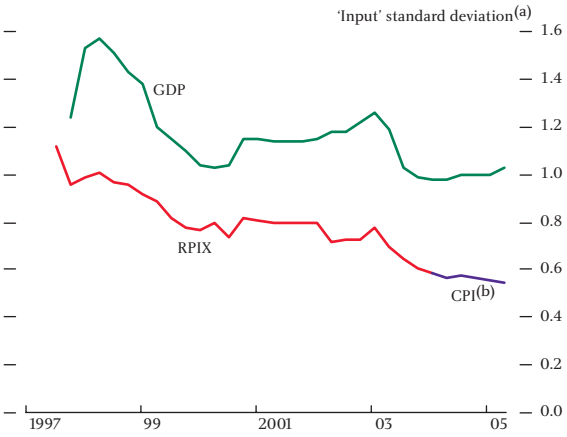
The variability of inflation and output growth has fallen substantially since the mid-1990s (Chart 5). Reflecting that, the dispersion of outturns around the Bank of England and MPC central projections has tended to fall over time. Because the MPC uses a rolling ten-year average of past forecasting experience to inform its judgement of uncertainty, the increased stability in outcomes has been translated into narrower fan charts: the width of the inflation fan chart has almost halved since 1998 (Chart 6).

Chart 5
Variability of GDP and inflation



(a) Of four-quarter rates of increase over the previous ten years.
(b) Consumption deflator between 1956–75, RPIX thereafter.

Chart 6
The uncertainty parameter in successive fan charts



(a) At the nine quarter ahead horizon. This is the parameter which the MPC chooses each quarter to set the width of the fan chart. It is σ in the appendix of Britton *et al* (1998).
(b) In the absence of information on errors forecasting CPI inflation, judgements about the width of the CPI fan charts were based on RPIX forecast errors.

The widths of the most recently published inflation fan charts are broadly in line with the variability of recent forecast errors. The standard deviation of the May 2005 fan chart was similar to the actual standard deviation of forecast errors over the previous five and ten-year windows (Table C). That suggests the MPC's judgemental adjustment to the width of the inflation fan chart in May 2005 was relatively small. And that the width of the fan chart was not overly sensitive to the size of the window of forecast errors. For GDP fan charts, the

Table C
Fan chart standard deviations compared with past outturns

	RPIX inflation		GDP growth	
	Five quarters ahead	Nine quarters ahead	Five quarters ahead	Nine quarters ahead
May 2005 fan chart	0.4	0.5	0.7	1.0
Past outturns:[a]				
since 1985 Q1	0.7	1.1	1.5	1.3
since 1995 Q1	0.4	0.4	1.0	0.8
since 2000 Q1	0.4	0.4	0.5	0.6

(a) The standard deviation of forecast errors, based on comparing the Bank of England's/MPC's mode forecast assuming constant interest rates with outturns.

assumed standard deviation is in line with the deviation since 1995 Q1, but is higher than the deviation of errors since 2000 Q1.

Should the MPC have learned about the more stable economic environment more quickly, and narrowed the fan charts accordingly? Perhaps more important than any statistical test of past fan charts is an economic assessment of the degree of uncertainty. Although we can observe the decline in variability in inflation and GDP growth in Chart 5 we cannot yet confidently explain it. We do not yet know to what extent the greater stability reflects a permanent change in the environment, such as the new monetary policy framework; and to what extent it has reflected temporary factors that may not persist.(1)

Since its inauguration, the MPC has discussed many risks to its central projections, and the fan charts have been calibrated to reflect those discussions. Some of those risks have materialised and some have not. But just because an identified risk did not crystallise, it does not mean it should not have been incorporated in the fan charts.

To take one example, the stability of inflation in recent years may have partly reflected inflation expectations remaining firmly anchored on the inflation target. But it would not be sensible for the MPC to assume that expectations will always be so anchored. There is a risk that inflation expectations could shift, say in response to a price level shock. In setting interest rates, the MPC must always remain vigilant to such a possibility.(2)

So to conclude, there does not seem to be compelling evidence that the MPC's fan charts should have been narrower. And the width of the latest inflation fan charts is in line with past experience of the volatility of outcomes.

The central tendency of the fan charts

The starting point of the MPC's forecast process is to make an assessment of the most likely path for the economy for a given profile of interest rates (see Britton *et al* (1998)). That path is called the central projection, and corresponds to the mode of the distribution of outcomes (the single most likely outcome). The Committee then considers the balance of risks around that mode projection, and may judge the distribution to be skewed. The MPC's mean projection will then reflect both its view on the most likely path for the economy, and the balance of risks. For reasons discussed in the box on page 332, in this section we will focus exclusively on the accuracy of the MPC's mean projection. But as is made clear by the fan charts, the probability that the economy will exactly follow the MPC's mean projection — or indeed any particular path — is small.

There is a large academic literature on how to assess the accuracy of such 'point forecasts'. One measure employed in the literature is the 'forecast error', which is the difference between a point forecast and the corresponding data outturn. But note that it is misleading to refer to the gap between the eventual outturn and the MPC's mean projection as an 'error'. The fan charts make clear that there is low probability of the MPC's central projections actually occurring. Nevertheless, to align with the existing literature, we will continue to use the term 'forecast error' to describe the deviation between the mean forecast and the outturn.

Assessing the mean projections: conceptual issues

One way to assess the MPC's forecasts is to compare the characteristics of their 'forecast errors' against the following, well-established criteria:(3)

(a) The mean forecast error should be zero (which implies no bias).

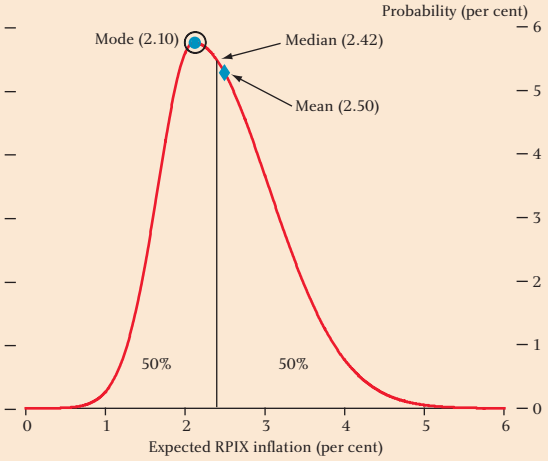
(b) It should not be possible to improve the accuracy of the forecasts by multiplying them by a constant (which we shall call 'weak efficiency').

(1) See, for example, Benati (2005), and King (2003).
(2) See, for example, King (2005).
(3) See Diebold and Lopez (1996). Note that some authors, for example Nordhaus (1987), used a different definition for weak efficiency.

Which measure of central tendency should we focus on?

For each MPC fan chart, there are potentially three measures of central tendency that could be assessed: the mean, the median or the mode.(1) The modal projection is the single most likely point, the median is the central point, with 50% probability of outturns lying on either side. And the mean is the expected outcome — the sum of all possible outcomes, weighted by their likelihood — and better reflects the entire probability distribution. These are illustrated in Chart A.

Chart A
The mean, median and mode



If the distribution in Chart A accurately described the likelihood of RPIX inflation outturns at a particular date in the future, then the expectation of the average inflation outturn would be the mean, rather than the mode or the median. Only the mean weights all possible outcomes by their probabilities.

To take an example, imagine one is offered a bet on the toss of a coin: heads wins £10, tails loses £10. Suppose the coin is weighted so that it lands on heads two thirds of the time. The most likely outcome (the mode projection) if the bet is made only once is a profit of ten pounds. But if the bet were made many times, the expected winnings would reflect the fact that a loss would occur one third of the time. So the mean forecast of profit for each play would be £6.67.

The mean projection is then the expectation of the average outturn from a large sample of observations. Indeed if the sample is large enough, and the probability distribution has been correctly specified, we would expect the average outturn to equal the mean projection. That would not necessarily be true of the mode or median projection.

Therefore, it is more appropriate to compare outturns with the MPC's projection of the mean, rather than the mode or median. Comparing the MPC's projection of the mean with outturns is akin to a joint test of the MPC's judgements on the central projection (mode), and on the balance of risks.

(1) These are made available on the Bank of England website in the week following the publication of the *Inflation Report*.

(c) Nor should it be possible systematically to use any other information, available to the forecaster at the time, to improve forecast accuracy (which we shall call 'strong efficiency').

These properties are illustrated in the box on page 333.

Regression tests

Typically, researchers test for bias and efficiency by estimating various regression equations. Let Y_t be the variable we are forecasting, and let Y_t^{t+i} represent the mean projection of Y_{t+i}, from time t the latest data point(1) (an i quarter ahead forecast). Define the i quarter ahead forecast error $e_t^{t+i} = Y_{t+i} - Y_t^{t+i}$, and let u_t be a zero-mean error term.

To test for bias, property (a), we can estimate the regression:

$e_t^{t+i} = \alpha + u_t$; unbiasedness requires $\alpha = 0$ **(1)**

For a joint test of bias and weak efficiency (b) estimate:

$Y_{t+i} = \alpha + \beta Y_t^{t+i} + u_t$; unbiasedness requires $\alpha = 0$ and weak efficiency requires $\beta = 1$. **(2)**

(1) Data for the current quarter are not available when the forecast is made. So a 'one quarter ahead' forecast (Y_t^{t+1}) is a forecast of the current quarter. For example the one quarter ahead forecast in August 2005 is for the outturn in 2005 Q3.

Some illustrations of biased or inefficient forecasts

This box shows some examples of forecasts that have undesirable properties, to illustrate the regression tests.

In Chart A, both forecasts are biased. Forecast 1 is persistently too high, and forecast 2 is too low. They would fail regression test 1 as described on page 332 above.

Chart A
Examples of forecasts that are biased

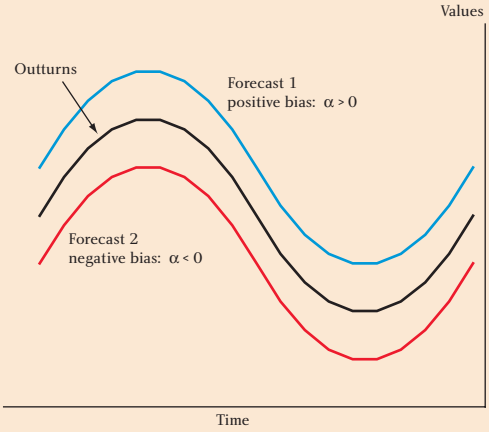
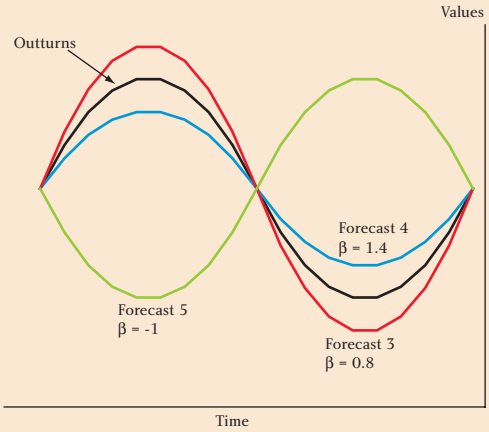


Chart B shows three forecasts, which are weakly inefficient. They have been constructed such that they are unbiased over the sample shown — they would all pass regression test 1 — but would fail regression test 2, described on page 332 above.

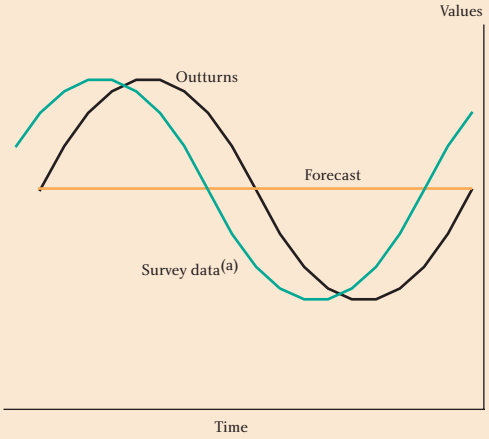
All of the forecasts in Chart B could be made more accurate if they were multiplied by a constant. Forecast 3 is too volatile, indicated by an estimated β that is less than 1. That might occur if a forecaster uses a model which puts too much emphasis on a piece of information. Forecast 4 is not volatile enough ($\beta > 1$), which might occur if the forecaster put too little weight on some information. Forecast 5 is negatively correlated with the actual outturns ($\beta = -1$). That might occur, for example, if the forecaster misinterprets some information. Chart B illustrates that even forecasts that are unbiased may not give a good guide to the future.

Chart B
Examples of forecasts that are weakly inefficient



Finally, Chart C gives an example of a forecast that is strongly inefficient. In this example, the variable is forecast to be a constant, when in fact the outturns are cyclical. By construction, the forecast is not biased, and could not be improved by being multiplied by a constant. So the forecast would pass regression tests 1 and 2. But it could clearly be improved if it took account of the survey data, which appears to lead the cyclical behaviour of the variable being forecast. So it would fail regression test 3.

Chart C
An example of a series of forecasts that are strongly inefficient



(a) Available to the forecaster before the forecast was made.

For a joint test of bias and strong efficiency (c) estimate:

$$Y_{t+i} = \alpha + \beta\ Y_t^{t+i} + \lambda\ Z_t + u_t; \text{ where } Z_t \text{ is any information available to the forecaster at time } t. \quad \textbf{(3)}$$

Strong efficiency implies that $\alpha = 0$, $\beta = 1$, and $\lambda = 0$. In Table D, we test $\lambda = 0$ to assess the information in Z_t.

When regression tests can be misleading

Before reporting the results of regression tests of the MPC mean projections, we should note two ways that this type of regression analysis can be misleading.

Persistent errors

A run of errors in the same direction is sometimes taken as evidence of bias or inefficiency. The forecaster does not appear to have learnt from past errors. But when considering persistence in errors it is important to distinguish between forecasts of the next period (one step ahead projections), and forecasts that look many periods into the future (multi step ahead projections). It is only for one step ahead forecasts that the previous error can be observed before the next forecast is made.

Over long forecast horizons — when looking two years ahead — MPC forecast errors have tended to be persistent: there have been periods of up to two years when outturns have been consistently higher or lower than expected. But that is not necessarily evidence of poor forecasting. Indeed, we might expect to see this pattern, even if the forecasts were the best possible given the available information (see the box on page 335). Analysis of forecast errors, based on informal observation or regressions, will be misleading if it does not take sufficient account of this unavoidable persistence in errors.

Small sample size

Generally speaking, the smaller the sample size, the less powerful regression tests are. Small samples imply a greater degree of uncertainty around estimated parameters, so the results are less likely to be statistically significant. This would seem to imply that the smaller the sample, the smaller the probability of finding significant evidence that a set of forecasts is biased. But in fact the opposite can be true. For multi step ahead forecasts, with a high probability of persistence in forecast errors, the smaller the sample, the harder it can be to judge whether results are significant or not (see Appendix B).

Typically, for evaluations of two year ahead economic forecasts, researchers have used samples of at least 20 years, for example Artis (1996), Clements and Hendry (2001) and Melliss and Whittaker (1998). There have been some exceptions: an examination of the National Institute's forecast errors (Poulizac *et al* (1996)) used 13 years of data. Nevertheless, with only six years of MPC forecasts that can be compared with outturns, the sample is probably too small to draw strong conclusions.

Assessing the MPC's mean projections: results

In this section we present tests of the MPC's one step ahead and multi step ahead mean projections. It is worth noting that the GDP growth forecasts are assessed against the most recently published estimates, which for older observations may have gone through several rounds of revisions. This will prove to be important later in explaining the pattern of GDP growth forecast errors. RPIX data are not revised.

One quarter ahead mean projections

First, we report tests of the MPC's one quarter ahead projections. In forming its policy decision, the MPC places greater weight on forecasts over longer time horizons, because policy takes substantially longer than a quarter to have an effect on GDP and inflation. But one quarter ahead forecasts are still important. Each quarter the MPC monitors one quarter ahead forecast errors to assess the shocks affecting the economy. A large one quarter ahead forecast error could cause the Committee to revise its view of prospects further ahead.

The MPC has published forecasts for RPIX inflation and GDP growth since August 1997.(1) At the time of writing, there were 26 one quarter ahead projections of RPIX and 31 of GDP that could be compared with outturns. For one quarter ahead projections of RPIX inflation, as discussed above, forecast errors should not be persistent, because the forecaster observes the previous forecast error before making the next projection. So regression results should not be affected by serial correlation. And as each observation is then effectively independent, the sample may be large enough for regression results to be informative.

Regression results are reported in Table D. We report the estimated parameters behind each hypothesis test, and the p-value associated with each test in brackets. Again, p-values lie between 0 and 1, and the larger the p-value, the less evidence there is that the projections failed the test. Orange shading indicates a p-value above 5%, implying acceptable forecast performance.

The RPIX projections perform reasonably well in the regression tests. The average error is zero and is not statistically significant (test 1 in Table D). Tests for weak efficiency (test 2 in Table D) suggest that the forecasts have given a reasonably good guide to outturns — α is

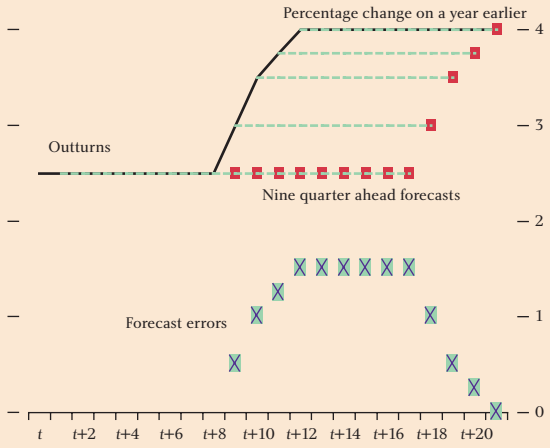
(1) The mean projection based on market interest rates was first published in February 1998. All of the MPC's projections can be downloaded from the Bank of England website.

Why multi step ahead forecasts often generate persistent forecast errors

The MPC fan charts under consideration in this article looked two years into the future, and were published each quarter. Adjacent projections overlap to a large degree. If events push outturns above the mean projection from one fan chart, it is likely that there will be similar forecast errors for other fan charts that cover that period.(1) This is illustrated in Chart A.

The red squares represent adjacent nine quarter ahead forecasts of the annual percentage change of, say, GDP. The first red square represents a forecast made at time t of growth in period $t + 9$. We assume that the best forecast is the most recent outturn. For the first nine periods, GDP growth outturns are 2.5%, so the best projection is 2.5%. Now suppose that in period $t + 9$, growth increases to 4% and stays there for several years. All the forecasts made before the shock occurs (between t and $t + 8$) turn out to be too low. So there is a long run of forecast errors, all of the same sign (the blue crosses). It is only by period $t + 9$ that the forecaster observes the shock, and can amend his forecast for growth in period $t + 18$ accordingly. So in the example, the length of the forecast period dictates the likely persistence in forecast errors, even for perfectly rational forecasts.

Chart A
Example of nine quarter ahead projections of a persistent series



(1) See Pagan, A (2003) for an algebraic example.

Table D
Regression results on one quarter ahead projections(a)

Tests:	Hypothesis	RPIX inflation	GDP growth
1) Bias	$\alpha = 0$	0.0 (0.73)	0.6 (0.01)
2) Bias and weak efficiency	$\alpha = 0$ $\beta = 1$	0.5 0.8 (0.08)	1.8 0.5 (0.05)
3) Strong efficiency(b)	$\lambda = 0$		
Z = previous forecast error		0.0 (0.88)	0.6 (0.03)
Z = previous outturn		0.0 (0.82)	0.3 (0.78)
Z = change in exchange rate		0.0 (0.90)	0.1 (0.25)
Z = import price inflation		0.0 (0.44)	–
Z = CIPS business activity		–	0.4 (0.54)

(a) For mean projections based on market expectations for interest rates. RPIX forecasts made between February 1998 and November 2003, GDP forecasts made between February 1998 and February 2005. The table cells are shaded if the p-value associated with each test (in brackets) is greater than 0.05, or in other words if at 95% confidence limits, there is no significant evidence that projections are biased or inefficient. RPIX residuals displayed no evidence of serial correlation. But it was present for GDP equations, so p-values are based on Newey West standard errors.
(b) Uses real-time GDP data, rather than latest estimates, as that is all that was available at the time the forecast was made.

not significantly different from zero and β is close to one, although the p-value is only marginally above 0.05. Four variables were included in the tests of strong efficiency (test 3 in Table D), but none of them significantly improved forecast accuracy. Tests of the GDP projections should be treated with caution as the equation residuals are serially correlated, and the Newey West correction may not be reliable given the sample size. There is significant evidence of bias, and the forecasts fail the weak efficiency test. But as we discuss below, those results can be explained by the tendency for output to be revised over time. The only evidence of strong inefficiency is that the previous forecast error (using real-time GDP) is significant. But it is not clear how much weight to put on this result given the importance of data revisions in explaining forecast errors.

Multi quarter ahead mean projections

Since 1999, each *Inflation Report* published in August has contained a box on the MPC's forecasting record. One focus of recent boxes has been to report average errors for one and two year ahead projections. These statistics are also reported on the Bank of England website.(1) As discussed above, average errors can give an indication of bias, but only if the sample size is large enough after taking account of the degree to which errors are serially

(1) www.bankofengland.co.uk/publications/inflationreport/irprobab.htm.

correlated. For one and two year ahead projections, the present sample size is probably too small to draw strong conclusions.

For the RPIX inflation projections, average errors have been close to zero, suggesting little evidence of bias (Table E). When commenting on the MPC's errors, Pagan (2003) said 'the bias is probably as small as one could reasonably expect'. Average errors forecasting GDP have been positive and further away from zero, so at least over this sample, GDP growth was on average stronger than the MPC expected.

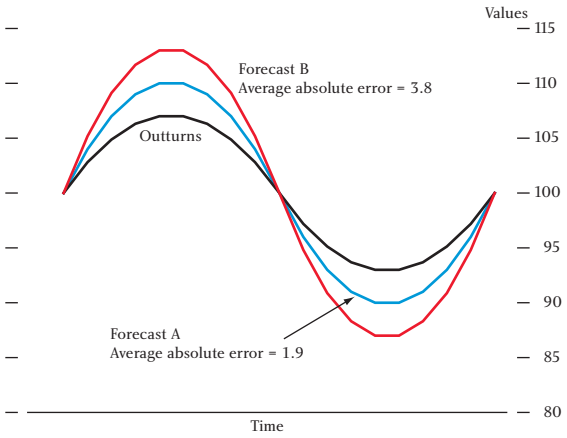
Table E
Average errors[a]

	RPIX inflation	GDP growth
Average errors		
One year ahead	0.0	0.5
Two years ahead	-0.3	0.3
Average absolute errors		
One year ahead	0.3	0.8
Two years ahead	0.4	0.7

(a) Calculated from mean projections based on market rates published since February 1998. For GDP projections, there are 25 observations for one year ahead projections, and 21 for two years ahead projections. For RPIX there are 24 observations for one year ahead and 22 for two years ahead.

Average errors give an indication of bias, but they cannot distinguish between an unbiased forecaster that makes large mistakes, and one that makes small mistakes. For example, in Chart 7, over the full sample, both the series of forecasts A and B have zero average forecast errors (the positive errors in the early phase are cancelled out by the negative errors in the later phase). Nevertheless, forecast A has been more accurate than forecast B. Calculating instead the average absolute errors would reveal that. The MPC average absolute errors are reported in Table E. They have been smaller for RPIX inflation than GDP growth.

Chart 7
Examples of unbiased forecasts with different absolute average errors



Forecast revisions

For multi step ahead projections, given the small sample of forecasts, and the associated serial correlation problems, the standard tests of bias and efficiency reported in Table D are not appropriate. But another test of efficiency is to examine how MPC projections of the same event (for example RPIX inflation in 2002 Q4) changed over time. Or in other words to examine the pattern of forecast revisions. Note that a forecast revision is a change in a forecast, which is quite distinct from a forecast error, which is the difference between a forecast and the eventual outturn. Unlike forecast errors revisions should not be systematically correlated over time even if forecasts overlap, see the box on page 337. Revisions can also be pooled to generate a larger sample. That allows a test of forecast efficiency for long-time horizon forecasts, even over a relatively small number of years.(1)

Table F below reports p-values from statistical tests of the degree of serial correlation, or predictability, of MPC forecast revisions. The higher the p-value, the less evidence there is of predictability, and so the less evidence of inefficiency. Following the format in Table B, cells have been shaded orange when there is no significant evidence that forecasts were inefficient at 95% confidence levels.

Table F
Tests for serial correlation in forecast revisions[a]

Forecast horizon[b]	RPIX inflation	GDP growth
6 quarters ahead	0.00	0.46
5 quarters ahead	0.01	0.10
4 quarters ahead	0.16	0.01
3 quarters ahead	0.49	0.08
2 quarters ahead	0.09	0.77
1 quarter ahead	0.45	0.88
Pooled over horizons[c]	0.34	0.30

(a) We test for serial correlation between revisions to a forecast of a single event by estimating the following equation:
$Y_t^{t+i} - Y_{t-1}^{t+i} = \alpha + \beta_1 (Y_{t-1}^{t+i} - Y_{t-2}^{t+i}) + \beta_2 (Y_{t-2}^{t+i} - Y_{t-3}^{t+i})$
Forecast revisions have been calculated from mean MPC projections based on market expectations of interest rates published between August 1997 and November 2004. We perform *F*-tests for one and two-period serial correlation, and report the p-values.
(b) This refers to the forecast horizon of the revision in the sequence being tested. So when $i = 1$ in the equation, it is labelled 1 quarter ahead in Table C, and so on up to 6. We stop at 6 because we require three earlier forecasts of the same event.
(c) The regression is estimated over all forecast horizons, but the constant term α was allowed to vary with the forecast horizon.

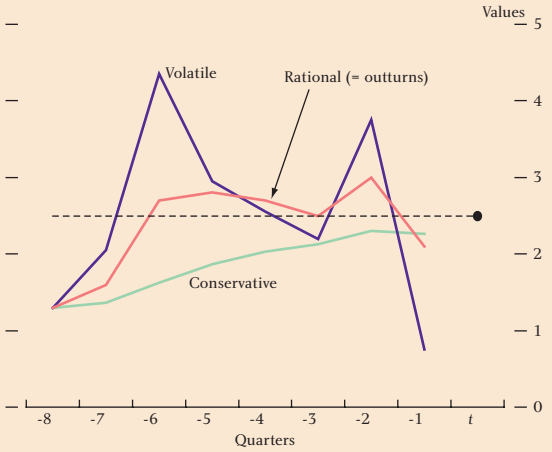
The tests indicate some evidence of correlation in revisions for long horizon forecasts of inflation, but in the majority of tests at specific horizons there is no evidence of serial correlation of forecast revisions. In the more powerful tests, when forecast revisions from all time horizons are pooled together, we do not find evidence of serial correlation. So in general, there is no

(1) See Bakhshi *et al* (2003).

Forecast revisions

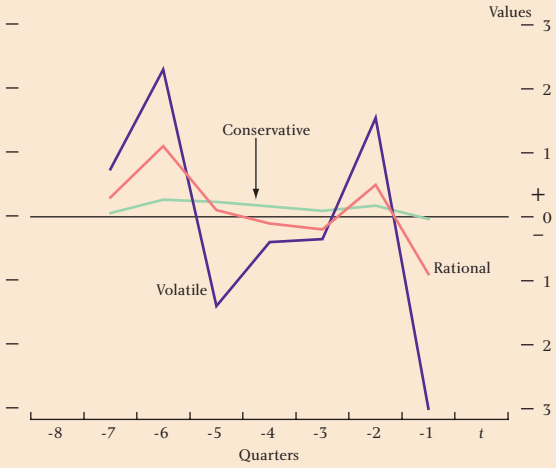
Forecast efficiency requires that revisions to forecasts of the same event should be independent over time. Otherwise, the forecaster could improve his forecast accuracy, by exploiting the predictable pattern in any forecast revisions. To illustrate this, Chart A shows examples of three types of forecaster, making successive forecasts of a single event. The rational forecaster makes optimal use of the news received each period. The conservative forecaster does not take enough account of this news, while the volatile forecaster overreacts to the news.(1)

Chart A
Successive forecasts of the outturn at period *t*



The revisions to the rational forecaster's projections are not predictable, by construction. In Chart B they appear random. This indicates that forecast accuracy could not have been improved by paying greater attention to revisions. By contrast, the conservative forecaster's revisions are predictable, because they are all in the same direction — they are positively serially correlated.

Chart B
Revisions to those forecast examples



Note: See footnote 1 below.

Similarly, the volatile forecaster's revisions are also predictable, because large revisions in one direction tend to be followed by large revisions in the opposite direction in the following period — the forecast revisions are negatively serially correlated.

Both the conservative and volatile forecaster could improve the accuracy of their forecasts by taking account of the predictability of their forecast revisions. The volatile forecaster should react less to the news, and the conservative forecaster should react more.

(1) The series being forecast is assumed to follow a random walk: $Y_t = Y_{t-1} + \varepsilon_t$. The forecasting rules in the examples are as follows:

Rational: $Y_t^{t+i} = Y_t$
Conservative: $Y_t^{t+i} = 0.2\ Y_t + 0.8\ Y_{t-1}^{t+i}$
Volatile: $Y_t^{t+i} = Y_t + 1.5\ (Y_t - Y_{t-1})$

strong evidence that MPC forecasts at most horizons could have been improved by taking into account any predictable, systematic pattern in forecast revisions. In that sense, the forecasts have been efficient.

How do MPC mean projections compare with external projections?

Another test of the MPC projections is to compare performance with equivalent projections made by other forecasters. If, over a large sample, the errors of external forecasters were clearly smaller than the MPC, that would indicate a form of strong inefficiency. Here we compare the MPC projections with forecasters surveyed by the Bank of England. Each quarter, a survey of forecasts of GDP growth and inflation is published in the *Inflation Report*.(1) The survey covers around 30 different forecasting bodies, including commercial banks, economic consultancies and academic institutions and each quarter around 20

(1) See for example the box on pages 45–46 in the February 2005 *Report*.

send in new forecasts. The forecasts are all made at roughly the same time as the MPC projection is finalised.

In Table G below, we compare the MPC average forecast error and average absolute forecast error with the equivalent measures of performance of the external forecasters. The 'pooled externals' row shows the indicators of performance of a forecast constructed by taking the average of all external forecasts. Compared with the MPC, measured bias was a little lower for this pooled forecast (indicated by a lower average error), and the size of the errors was a little smaller (as indicated by the average absolute error). That reflects the well-established result that pooling forecasts often generates a more accurate forecast than putting 100% weight on any one.

Table G
The forecast record of MPC mean projections compared with other forecasters[a]

	GDP		RPIX	
	Nine quarters ahead	All horizons[b]	Nine quarters ahead	All horizons[b]
Average errors				
MPC	0.3	0.5	-0.3	-0.1
External forecasters	0.3	0.4	-0.1	-0.1
Average absolute errors[c]				
MPC	0.7	0.7	0.4	0.3
Pooled externals	0.7	0.7	0.3	0.2
Individual externals	0.8	0.8	0.4	0.3

(a) Uses the MPC's mean projections under market expectations of interest rates published between February 1998 and November 2003 for RPIX and November 2004 for GDP. External forecasts are as surveyed by the Bank of England and published in the *Inflation Report*. Average errors are calculated on exactly the same basis for MPC projections and external forecasters.

(b) Forecasts from different horizons have been pooled, because the survey asks for a forecast at a specific point, rather than at a fixed horizon (ie RPIX inflation in 2004 Q4, rather than in two years' time). Therefore, with the exception of nine quarter ahead projections, the samples of forecasts at a given horizon are small. For example for GDP projections they are as follows: one quarter ahead to four quarter ahead, seven observations; five quarter ahead to eight quarter ahead, six observations; nine quarter ahead, 21 observations.

(c) Let $e_{i,j}$ be the forecast error of external forecaster i in relation to an event j, where each combination of forecast date and forecast horizon is considered a separate event. So for example horizon 3 and 7 forecasts at time t are separate events; and horizon 2 forecasts at time t and $t+1$ are also separate events. Then the 'pooled external' row is calculated as $\frac{1}{M}\sum_{j=1}^{M}\left[\frac{1}{N}abs\left(\sum_{i=1}^{N}e_{i,j}\right)\right]$ and the 'individual external' row as $\frac{1}{M}\sum_{j=1}^{M}\left[\frac{1}{N}\sum_{i=1}^{N}\left(abs\ e_{i,j}\right)\right]$. As described in footnote (b), the full sample for GDP comprises 73 events, while the sub-sample of nine quarters ahead forecasts has 21 observations. The samples for RPIX are 70 and 22 respectively.

The 'individual externals' row of Table G shows the average performance of individual forecasters. That removes the effect on forecast performance of pooling many different forecasts, and so in some sense is a fairer comparator for the MPC forecasts. A comparison of average absolute errors suggests that MPC forecast errors tended to be a little smaller for GDP growth, but were the same for inflation. But, just as with the other forecast tests, the sample size is too small to be conclusive.

What might have caused outturns to differ from the MPC's mean projections?

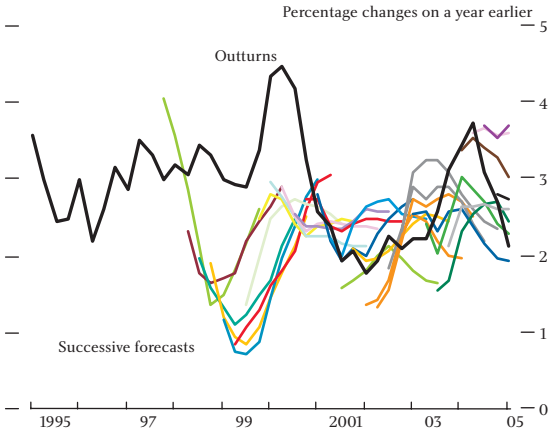
GDP mean projections

Chart 8 shows each successive mean projection made by the MPC for GDP growth. The chart highlights two periods that may be worth focusing on:

- Unexpectedly strong growth in 1999 and 2000.
- Unexpectedly weak growth in 2002.

One feature of Chart 8 is that the start point of projections made between 1998 and 2000 now appears to be too low, suggesting that growth has been revised up quite markedly since the projections were made. That is indeed the case (Chart 9). On average, the initial estimates of four-quarter GDP growth between 1998 Q3 and 2000 Q4 were 1.1 percentage points weaker than the current estimates. Furthermore, business surveys published at the time also suggested that growth was weaker than current ONS data suggest (Chart 10). The

Chart 8
GDP outturns and central projections[a]



(a) Mean projection based on market interest rates.

Chart 9
GDP outturns: initial and latest estimates

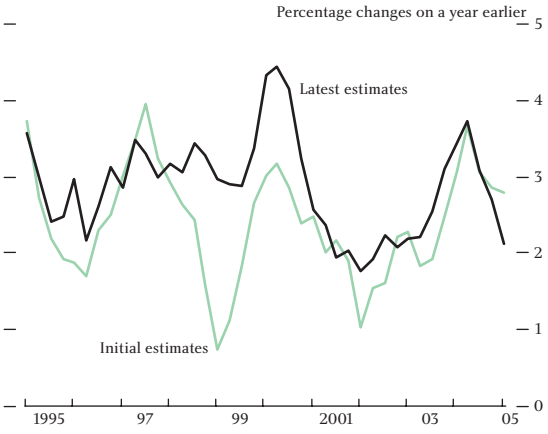
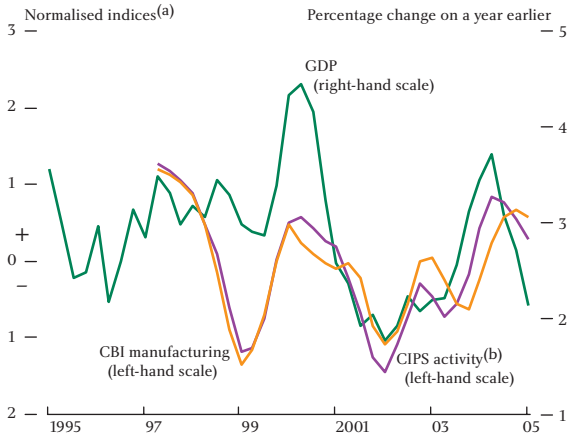


Chart 10
GDP and surveys of output



(a) Average index over preceding four quarters. Normalised by subtracting mean and dividing by standard deviation since 1996.
(b) Weighted sum of manufacturing output and services activity.

factors behind these GDP growth revisions are discussed in the box on page 340.

The initial underrecording of output growth undoubtedly led directly to errors in forecasting four-quarter GDP growth at short forecast horizons. For example, if we repeat regression (1) in Table D above, but add a variable that measures the degree to which the GDP data available at the time were misleading, then there is no longer any evidence of bias. The regression equation suggests that more than three quarters of the variance of the forecast error can be explained by data mismeasurement (Appendix C).

The key to understanding this result is to recognise that a one quarter ahead forecast of four-quarter GDP growth takes the first three quarterly growth rates as given by the data, and just requires a forecast of the final quarter. Any subsequent revision to the data will therefore feed one for one into the observed forecast error. So an assessment of short horizon forecasts should attempt to take account of revisions to the underlying data.

Could the tendency for initial GDP data to be revised have affected forecast errors over longer time horizons? It seems unlikely that two year ahead projections would be significantly affected. Forecasts of growth two years ahead are driven by factors like expected fiscal and monetary policy, external demand, and the expected evolution of asset prices, rather than current GDP growth. But forecast errors over shorter horizons are likely to have been affected.

Table H reports the correlation between forecast errors at different horizons, and the gap between the current estimate of GDP growth at the start of the projection and the estimate available at the time. All correlations are positive, suggesting that if actual growth was underrecorded, subsequent forecasts tended to be too weak. As expected, the correlation is strongest for one step ahead projections, and the correlation tends to fall as the horizon extends.

Table H
Correlation between errors forecasting GDP growth and revisions(a)

Forecast horizon	Correlation	Sample size
1	0.80	31
2	0.57	30
3	0.41	29
4	0.30	28
5	0.20	27

(a) To four-quarter growth at the start of the projection.

We turn now to the errors in 2002. MPC projections for growth in that year tended to be around 2.5% — somewhat higher than actual growth, which was around 2% (Chart 8). There was a pronounced slowing in growth from 2000. A major cause of the lower growth in GDP was the weakening of external demand. For example, a measure of world trade weighted according to UK export shares slowed from 12.4% growth in 2000, to just 3.1% in 2002. That led to a deceleration in UK exports, and a large negative net trade contribution (Table I).

Table I
Contributions to year-on-year GDP(a) growth

	2000	2002	Change
Household consumption	2.9	2.3	-0.7
Business investment	0.5	0.0	-0.4
Government consumption	0.7	0.9	0.1
Net trade	-0.1	-1.2	-1.1
GDP	4.0	2.0	-2.0
Memo: World trade(b)	12.4	3.1	-9.3

(a) Chained volume measures.
(b) Percentage changes on a year earlier. Weighted according to UK export shares.

The decline in world trade growth was sharper than the Committee had been expecting. For example, in the February 2001 *Inflation Report* the MPC noted that 'Growth in UK-weighted export markets is most likely to slow from around 10½% in 2000, to just under 7% in 2001 and to 6% in 2002'. Given that around a third of UK output is exported, that would have been sufficient to explain the lion's share of the weaker-than-expected GDP growth, especially if one takes account of the likely second-round effects on UK business investment and household consumption of weaker exports.

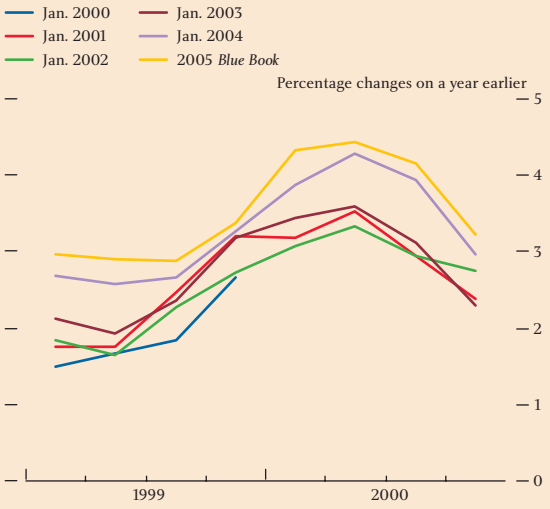
Revisions to GDP growth in 1999/2000

We have seen that the initial understatement of GDP growth in 1999 and 2000 appears to have led the MPC to under-forecast GDP growth. What lay behind the weakness of the initial ONS estimates?

The ONS publishes a first estimate of quarterly GDP growth within a month of the quarter finishing. Such timely first estimates are useful, but they are inevitably subject to revisions. They are based on incomplete information, and as more information comes in, the ONS is able to produce more accurate estimates. Furthermore, as the ONS builds a more complete picture of the economy, it will improve the way that GDP is measured, for example by using more accurate weights to sum components. The MPC is well aware of the likelihood of data revisions and takes account of that when making forecasts.(1) But as is clear from Chart 9, the revisions to the initial estimates of growth in 1999 and 2000 were particularly large.

From Chart A, we see that estimates of growth in 1999 and 2000 were revised several times as the ONS received more information. Growth was generally revised up from the previous estimates, apart from in January 2002. By far the largest upward revisions were made in 2003, several years after the MPC's projections for growth in 1999 and 2000 had been made.

Chart A
GDP: different vintages of ONS data



The 2003 revisions were made in the September release of the National Accounts when annual chain-linking was first introduced. The changes are discussed in a box in the November 2003 *Inflation Report*. The upward revisions to growth in 1999 and 2000 reflected new estimates of deflators of investment, exports and imports, as the ONS updated the weights it used. The changes were not directly related to annual chain-linking. So even though the MPC knew that the ONS was moving to annual chain-linking, these specific revisions were not predictable.

(1) See, for example, Ashley, Driver, Hayes and Jeffrey (2005).

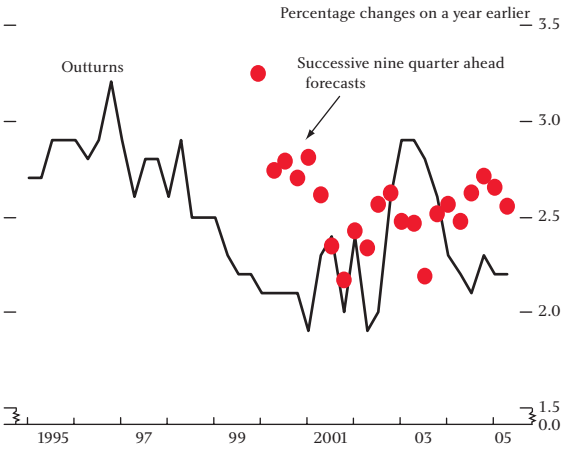
RPIX mean projections

Similar analysis of RPIX outturns and forecasts, as in Chart 11, suggests we should look at three episodes:

- the unexpectedly low inflation between 1999 and 2002;
- the unexpectedly high inflation in 2003; and
- the unexpectedly low inflation in late 2004 and early 2005.

Table J shows the contribution to RPIX inflation from four broad categories of goods and services. Changes in underlying inflation are monetary phenomena which reflect, among other things, expectations of monetary policy. But shocks in certain sectors may also affect aggregate inflation over short time horizons. The decomposition in Table J gives an indication of the type of shocks that may have had a temporary effect on inflation, allowing us to explore

Chart 11
RPIX inflation outturns and two year ahead mean forecasts(a)



(a) Mean projection based on market interest rates.

Table J
Contributions to RPIX annual inflation

	Average 1995–98	Average 1999–2002	2003	2004	2005 H1
Tradable goods[a]	0.8	-0.2	-0.1	-0.2	-0.5
Petrol, fuel and light	0.2	0.2	0.2	0.4	0.6
Housing[b]	0.5	0.8	1.2	1.0	1.1
Other (services and food)	1.3	1.4	1.5	1.0	0.9
RPIX	2.8	2.2	2.8	2.2	2.2

(a) Household and leisure goods, clothing and footwear, motor vehicles, alcohol and tobacco.
(b) Housing depreciation, rent and council taxes.

whether forecast errors have been attributable to those shocks.

The reduction in inflation between the periods 1995–98 and 1999–2002 is most noticeable in the category of 'tradable' goods. Indeed, price inflation for all other broad categories picked up (Table J). Is it possible that tradable goods prices were weaker than the MPC anticipated? The MPC did not make a forecast of the decomposition of RPIX prices. But, as is clear from Table K, the MPC's projections between 1997 and 1999 were based on assumptions for the exchange rate that turned out to be too low. For some projections, that gap was large. As a result, import prices tended to be lower than the Committee had been expecting. And this suggests that the sustained weakness in tradable goods price inflation, particularly between 1999 and 2000, probably led to some of the overprediction of inflation.

Table K
Exchange rate[a] projections and outturns

Forecast period[b]	Start point	Assumed level in two years[c]	Outturn	Percentage difference
1997	105.1	90.0	103.8	15.3
1998	104.7	99.7	106.4	6.7
1999	103.1	96.6	106.1	9.8
2000	106.1	104.6	105.7	1.1
2001	106.7	104.7	99.2	-5.3
2002	105.7	103.5	104.8	1.3
2003	98.6	96.7	102.5[d]	6.0

(a) As measured by the old IMF-based sterling effective exchange rate index, see Lynch and Whitaker (2004)
(b) Taken from August *Inflation Report* of each year.
(c) The projection in 1997 was based on judgement. In 1998 and 1999 the exchange rate was assumed to follow the path determined by UIP. From November 1999, it was assumed to follow the average between a flat path, and the UIP path.
(d) Average for July and August 2005.

In 2003, RPIX inflation was around 0.5 percentage points higher than the MPC had anticipated in earlier years (Chart 11). In that period, the housing components of the RPIX, and particularly housing depreciation (which is estimated from house price inflation) picked up sharply. House price inflation rose to over 20%, enough to raise RPIX inflation by 0.4 percentage points (Table G). These developments in the housing market were not anticipated by the MPC when preparing earlier projections. For example, in the November 2001 *Inflation Report*, 'house price inflation [was] projected to ease to a little below the growth rate of nominal earnings in the medium term'.(1) So the unexpected increases in RPIX inflation in 2003 largely reflected unexpectedly high house price inflation.

This exercise is less helpful in determining why RPIX inflation in 2004 and early 2005 was lower than expected by the MPC. As is clear from Table K, the exchange rate turned out to be considerably stronger than the assumptions in forecasts made in 2003. The appreciation of the exchange rate in early 2004 probably contributed to the higher rate of decline of imported goods, and that may explain part of the unexpectedly low RPIX inflation. But on the other hand, the MPC were not expecting such large increases in house prices or in oil, both of which pushed up on RPIX inflation in 2004 and 2005, relative to expectations. GDP growth was weaker than expected in early 2003, but stronger than expected in late 2003 and 2004. So the unexpectedly low inflation cannot be explained by unexpectedly weak demand. That raises the question, did potential supply grow faster than the MPC had expected?

The short-run trade-off between GDP growth and inflation

One factor that is common to MPC projections, and to external forecasts, is that between 1997 and 2003, RPIX inflation tended to be a little lower than expected, while GDP growth tended to be unexpectedly strong (Table D). To some extent that can be explained by unexpectedly weak import prices discussed above, which would tend to push down on inflation without necessarily depressing GDP growth. But there are several other candidate explanations relating to improvements in the UK supply side. Those include: developments in the UK retailing sector, which may have reduced the impact of demand on retail prices; government reforms to the labour market, which may have lowered the equilibrium rate of unemployment; and increased inward migration.

Since its inception in May 1997, as a result of monitoring the UK economy, and comparing outturns with mean projections, the MPC has made several adjustments to its assumptions about the relationship between activity and inflation. This continues to be an area of considerable uncertainty: see, for example, the discussion of risks on page 43 of the November 2004 *Inflation Report*. But further analysis of forecast errors should shed light on the accuracy of the MPC's assumptions on the supply side.

(1) Page 47.

Conclusions: an assessment of the MPC's projections

Fan charts

There is inevitably uncertainty around the outlook for the economy, and to communicate this, the MPC publishes its projections as fan charts. The purpose of this article has been to assess those fan chart projections.

We have considered various issues that arise when analysing fan chart projections. Perhaps the key point is that with only six years' worth of projections that can be compared with outturns, the sample is probably too small to draw firm conclusions. Furthermore, any assessment of the fan charts must take account of the likely serial correlation in forecast performance, which is a natural consequence of overlapping forecasts — ones that are repeated each quarter, and look many quarters into the future. Failure to take account of these and other issues runs the risk of drawing incorrect inferences about forecast performance.

With that in mind, we draw the following tentative conclusions:

- In general, between 1998 and 2005, GDP and RPIX outturns were dispersed broadly in line with the MPC's fan charts. So the fan charts gave a reasonably accurate summary of the risks and probabilities faced by the MPC.

- But for near-term projections of GDP growth, outturns were more dispersed than implied by the fan charts. To a large part that reflected unexpectedly big revisions to output data. In August 2005, the GDP fan charts were widened at short horizons to indicate better the level of uncertainty.

- For two year ahead projections of both GDP growth and inflation, outturns were less widely dispersed than implied by the MPC fan charts. But this is not strong evidence that those charts fanned out too widely. Each fan chart includes probabilities of many risks, and some of those risks will not occur. That does not mean that the risks were absent.

- The method used by the MPC to calibrate risk has tended to make fan charts narrower over time, in response to the recent economic stability. It is not clear that there is a strong case for making the latest inflation fan charts any narrower than they already are.

Mean projections

The probability of outturns following the mean projection from an MPC fan chart is small. But the profile of the mean is a key feature that summarises the shape of a fan chart, so it is instructive to assess how close outturns were to the mean projections. We draw the following conclusions:

- In the past five years, there have been periods when GDP and RPIX outturns were above or below the MPC's mean projections for several quarters in a row. But that it is not evidence of poor forecasting. For repeated forecasts that look many quarters into the future, it is what we might expect, even if the forecaster is making best use of all available information.

- In general, we conclude that the performance of the MPC's mean projections has been reasonably good when tested against a number of criteria, and when compared with other forecasters.

- Nevertheless, it is useful to ask what may have caused outturns to differ from the MPC's mean projections. The tendency for RPIX outturns between 1999 and 2002 to be lower than expected was related to the unexpected strength of the sterling exchange rate. And unexpectedly high inflation in 2003 reflected stronger-than-expected house price inflation. To some extent, the MPC's forecasts of GDP growth between 1998 and 2000 were too weak because the data available at the time, including both ONS data and business surveys, understated activity. And a principal cause of the unexpectedly weak GDP growth in 2002 was a sharper-than-expected slowdown in world demand.

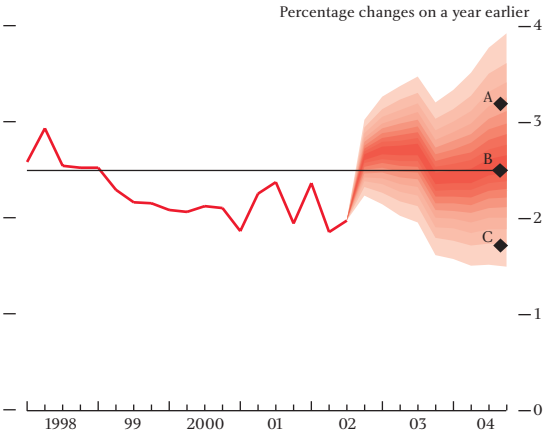
- The combination of unexpectedly low price inflation and unexpectedly strong output growth in the late 1990s and earlier this decade is consistent with various explanations. To a degree it appears to have reflected unexpectedly low import prices. But, in part as a result of monitoring outturns relative to its projections, the MPC also judges that the UK potential supply may have grown more rapidly than previously anticipated.

Appendix A: Density tests of the fan charts

This appendix sets out more formally how the tests of the fan charts are constructed. The fan chart describes the expected probability density function of inflation and GDP growth. Whatever the nature or shape of those probability distributions, we know that if they accurately describe reality, then over a large enough sample, outturns should be uniformly distributed across all probability bands. Our tests assess whether that has been true. For example, if the fan charts say that there is a 10% chance of RPIX inflation lying between 2.0% and 2.2%, then we examine whether 10% of outturns have been between 2.0% and 2.2%.

The key to testing density forecasts is to carry out a so-called 'probability integral transform' (PIT) of each outturn to capture the relationship between outturn and forecast. The PIT is the probability implied by the fan chart that an outturn would be equal or less than what was actually observed. For example, in Chart A, the PIT for outturn A would be 0.75, it would be 0.5 for outturn B, and 0.1 for outturn C. So the PIT identifies where the outturn fell relative to the fan chart bands. We refer to this measure as the percentile in which the outturn fell. If the fan charts give a good guide to the eventual dispersion of outturns, there should be an equal chance that an outturn falls in any percentile of the fan chart. Therefore a sample of the PITs of realised inflation or GDP growth should be uniformly distributed. This is demonstrated formally by Diebold, Gunther and Tay (1998).

Chart A
Different outturns relative to the fan chart



We employ two tests: the Kolmogorov-Smirnov (KS) test, and a likelihood ratio test suggested by Berkowitz (2001). The KS test is the standard test in the literature for comparing two distributions, by converting outturns so that they can be compared with the uniform distribution. The KS test focuses on the largest difference between the empirical distribution and the assumed distribution and tests how significant that difference is. Consider the example in Table A1. Outturns have been compared with the expected probability distribution, using the probability integral transform. The probabilities are listed by rank in the 'outturns row'. These are compared with the uniform distribution probabilities (row 2). The largest discrepancy from the uniform distribution is the first outturn, where the difference between probabilities is equal to -0.15.

Table A1
Example of applying KS test

Rank	1	2	3	4	5
Outturns	0.35	0.4	0.6	0.9	0.95
Uniform distribution	0.2	0.4	0.6	0.8	1.0
Difference	-0.15	0	0	-0.1	0.05

Kolmogorov and Smirnov derived a formula for testing the significance of this difference (See eg Kendall and Stuart (1979)). Let d = the difference, and let N = the number of observations. Then the p-value is given by:

$$Q\left(\left[\sqrt{N}+0.12+0.11/\sqrt{N}\right]d\right)$$

Where $\quad Q(x)=2\sum_{i=1}^{\infty}(-1)^{i-1}e^{-2i^2x^2}$

In the numerical example, feeding in a probability difference of 0.15, with a sample size of 5 gives a p-value of 0.9995. So in the example, there is no evidence to reject the null hypothesis that outturns were drawn from the expected distribution. The higher the probability number, the greater the confidence we have in rejecting the alternative hypothesis that the distribution of outturns was significantly different from that expected.

One problem with the KS test is that it makes no allowance for the possibility of serial correlation in forecast errors. If serial correlation causes a bias in the average forecast error, this will be reflected in the PITs of the outturns. The observed distribution will depart from the predicted one, which may cause the test to reject. And as we have discussed, with frequent forecasts that

look a long way into the future, forecast errors are likely to be serially correlated.

The second test we apply is derived from Berkowitz (2001). Like the KS test, this is a test of equality of distributions. However Berkowitz suggested converting the sample of PITs of the outturns, using the inverse of the standard normal cumulative density function, so that they can be compared with the normal distribution rather than the uniform distribution. The advantage of moving to the normal distribution is that it is easy to construct standard likelihood ratio tests, which tend to be powerful. Berkowitz (2001) fits the following AR(1) model to the transformed probability values, which we refer to here as u_t:

$$u_t = \mu + \rho u_{t-1} + \varepsilon_t \quad \varepsilon_t \sim N(0,\sigma^2) \qquad \textbf{(1)}$$

Two likelihood ratio tests are suggested. The first is a joint test of the equality of the observed and assumed (standard normal) distributions, and of independence of the observations. The second attempts to disentangle these hypotheses, by testing for independence of the observed u_t while allowing the mean and variance of the AR(1) process to differ from zero and unity respectively.(1)

For brevity, however, we do not report results for these tests. Instead we design a third test, in a similar vein, which focuses on the question most of interest here: allowing for the possibility of serial correlation in the relationship between fan charts and outcomes, have the fan charts given a good guide to subsequent outcomes? Because we allow for serial correlation to be present, we might expect inference from this test to be more reliable than that from the KS test. Specifically, we fit the AR(1) model to the observed u_t, and test the null hypothesis that the mean and variance of the u_t are zero and unity respectively, while allowing the autocorrelation coefficient to be freely estimated. The test is given by:

$$LR = -2\left[L\left(0,\hat{\rho},\left(1-\hat{\rho}^2\right)\right) - L\left(\hat{\mu},\hat{\rho},\hat{\sigma}^2\right)\right] \sim \chi^2 \qquad \textbf{(2)}$$

Where $L(\mu,\rho,\sigma^2)$ is the standard log-likelihood function for an AR(1) process. We note that the distribution of the test statistic given in **(2)** is asymptotically valid, but is likely to be biased in small samples.

We allow for serial correlation in the form of an AR(1) as a simple approximation of the actual process we might expect. Forecast errors from a rational forecaster could be serially correlated as an MA process. For example, if quarterly growth rates of the variable being forecast are not serially correlated, rational forecasts of four-quarter growth rates should generate forecast errors that follow an MA(3) process. It is less clear what the precise autocorrelation structure of the PITs of the data should be, and so how good the AR(1) approximation is in practice. In this instance an AR(1) appears to give a reasonable approximation. Nevertheless, the results must be treated with caution.

(1) For more details of these tests see Berkowitz (2001).

Appendix B: How the size of the sample can affect statistical inference

This appendix reports a simple experiment to demonstrate how having a small sample can influence the probability of apparently finding significant evidence of forecast bias, even when it is not there.

Consider a series of forecast errors Y_t, which are serially correlated according to an MA(3) process:

$$Y_t = \varepsilon_t + \varepsilon_{t-1} + \varepsilon_{t-2} + \varepsilon_{t-3} \qquad \varepsilon \sim N(0,\sigma^2)$$

As discussed in the main text, it is likely that multi step ahead forecasts will generate serially correlated errors. More precisely, a rational forecaster should generate errors that follow an MA process. As the MPC's forecasts are of four-quarter growth rates, we would expect forecast errors to be at least MA(3) with unit roots. The longer the forecast horizon, and the more serially correlated the variable being forecast is, the more lagged terms we would expect in that MA process.

Because there is no constant in the equation, and each error term is mean zero, the errors are unbiased by construction.

A regression test for bias might involve regressing the errors on a constant:

$$Y_t = \alpha + u_t$$

and then testing to see if α is significantly different from zero. A naive test, that takes no account of serial correlation, might use a standard t test. Another alternative would be to use a t test, but based on standard errors calculated from a Newey-West variance-covariance matrix, which allows for serially correlated residuals.

Because we know the true distribution of the errors, we can use so-called 'Monte Carlo' techniques to assess the effectiveness of these tests. Using a random number generator we can generate a very large sample of data, and run repeated regression tests, to see how frequently they reject the hypothesis that the errors are unbiased.

We set the significance level of the tests at 5%, so if the tests were well specified they should only find significant evidence of bias 5% of the time.

From Table B1, it is clear that a combination of a small sample and serial correlation reduces the reliability of this simple test. Although by construction the implicit forecasts are not biased, the tests find evidence of bias too frequently. For the MA(3) process, standard t tests find evidence of bias around one third of the time, and when the sample is small, the Newey West adjustment does little to improve accuracy.

Table B1
The percentage of regression tests that found significant evidence of bias(a)

Sample size		Serial correlation			
		MA(3)	AR(1)(b)		
			$\lambda = 0.1$	$\lambda = 0.5$	$\lambda = 0.9$
20	t tests	37	11	25	69
	Newey West	24	9	18	57
1,000	t tests	33	8	25	67
	Newey West	10	6	6	14

(a) Each experiment involved running 1,000 regressions.
(b) $Y_t = \lambda Y_{t-1} + \varepsilon_t$.

The precise serial correlation of forecast errors cannot be known, so we also report the results for an AR(1) process with different values of lambda to illustrate the sensitivity of the test to the degree of serial correlation. Broadly speaking, a value of lambda between 0.5 and 0.8 should give a reasonable approximation of the degree of serial correlation we might expect for rational forecasts of four-quarter growth rates, depending upon the forecast horizon and the variable being forecast. As the results indicate, for such high degrees of serial correlation, the tests are not very reliable.

So when assessing the MPC's forecasts, it is important to bear in mind that the combination of a small sample of forecasts, and the likelihood of serially correlated errors, raises the probability of apparently finding significant evidence of bias when it is not actually present. The danger of misinterpreting the MPC's forecast record is increased further if analysis is confined to calculating simple average errors, or looking at charts.

Appendix C: Taking account of data revisions when testing for bias in GDP projections

In this appendix, we repeat the regression test reported in Table D in the main text, on one quarter ahead projections of four-quarter GDP growth. But we include a measure of the degree to which the initial GDP estimates available to the MPC, of quarterly growth in the preceding three quarters, have subsequently been revised. Because growth in the preceding three quarters enters the four-quarter growth calculation, there is likely to be a large direct effect from data revisions.

In Table C1 below we estimate the following equations:

$$Y_{t+1} - Y_t^{t+1} = \alpha \qquad \textbf{(1)}$$

$$Y_{t+1} - Y_t^{t+1} = \alpha + \beta R_t \qquad \textbf{(2)}$$

Where R_t is the revision to three-quarter GDP growth in the three quarters between $t - 3$ and t.

Table C1
Regression tests for bias on one quarter ahead projections of annual GDP growth(a)

	Constant (α)	Data revision (β)	R^2
Equation **(1)**	0.6 (0.00)	Not included	0.0
Equation **(2)**	0.0 (0.78)	1.2 (0.00)	0.8

(a) For mean production based on market expectations for interest rates, published between February 1998 and February 2005. The table cell is shaded orange if the estimated parameter is not significantly different from zero at 5% confidence levels and p-values are reported in brackets.

The results suggest that there has been a strong correlation between the MPC's forecast errors and the degree to which the initial data was subsequently revised. Once the test takes account of the extent to which the initial data were misleading, there is no longer significant evidence of bias. Indeed over three quarters of the variance of one quarter ahead forecast errors can be explained by the pattern of data revisions.

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Long-run evidence on money growth and inflation

By Luca Benati of the Bank's Monetary Assessment and Strategy Division.

We investigate the correlation between inflation and the rates of growth of narrow and broad money in the United Kingdom since the 19th century. Empirical evidence points towards a remarkable stability across monetary regimes in the correlation for longer-run trends in the data, but some instability in the short to medium term. Additional evidence from the United States confirms the overall stability of the correlation for the longer-run trends.

Introduction

Despite a continuing controversy over the short-run relationship between money growth and inflation, it is well known that, historically, increases (decreases) in the trend growth rate of the money supply have been very strongly associated with increases (decreases) in trend inflation.(1) In this article, we investigate the correlation between inflation and the rates of growth of narrow and broad money in the United Kingdom and in the United States since the 19th century.

Evidence for the United Kingdom

The correlation in the raw data

Chart 1 shows inflation and the rates of growth of base money, M3 and M4 in the United Kingdom since 1870.(2) This period encompasses several radically different monetary arrangements, including: the gold standard, until August 1914; the inter-war period, with the United Kingdom reintroducing the gold standard in 1925 and abandoning it again in 1931 to become the centre of a currency bloc known as the 'sterling area'; the period from the start of the Bretton Woods regime, in December 1946, until the floating of the pound *vis-à-vis* the US dollar, in June 1972; the period from June 1972 to the introduction of inflation targeting, characterised by a succession of different monetary arrangements and measures, culminating in UK membership of the Exchange Rate Mechanism (ERM) of the European Monetary System; and the post-October 1992 inflation-targeting regime, following sterling's abandonment of the ERM.

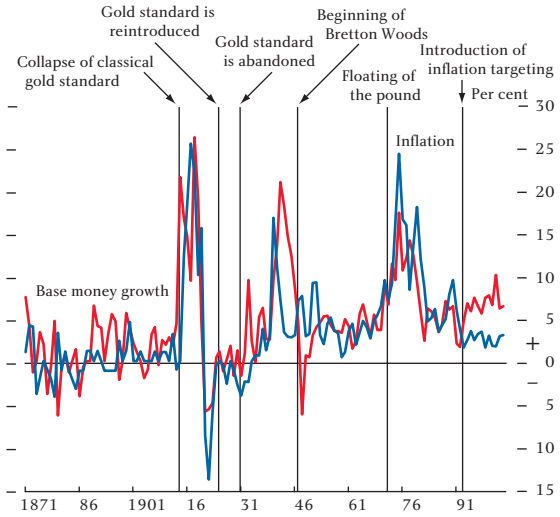
There was a very high correlation between inflation and the growth of base money and M3 around the time of the rapid monetary expansion associated with the outbreak of the First World War (WWI). By contrast, the correlation around the time of Second World War (WWII) was much weaker, possibly reflecting the UK government's greater use of price controls and rationing. (This is a crucial point, as 'virtual prices' — ie the prices at which agents would have willingly chosen to buy goods and services — may have been tracking movements in the monetary aggregates more closely.) The correlation between base money growth and inflation was again very strong around the time of the high inflation of the 1970s, while it appears to have broken down over the post-1992 period, with inflation at low and stable levels, and M0 growth, so far, increasing. For M4 the correlation appears to have been, overall, quite weak, with three periods — the first half of the 1970s, the second half of the 1980s, and the mid-1990s — in which the growth of M4 clearly exceeded that of prices. Only the first two of those periods were associated with a subsequent increase in inflation: under inflation targeting, the mid-1990s 'hump' in M4 growth did not produce any pickup in inflation, which remained anchored to its target.

The visual impression of quite significant changes over time in the correlation between inflation and money growth is confirmed by Table A, which reports simple correlations between inflation and money growth, both contemporaneous and lagged, by regime/period.

(1) De Grauwe and Polan (2001) present evidence that challenges the existence of a long-run relationship between money growth and inflation. Nelson (2003), however, casts considerable doubts on their results.
(2) Unfortunately, M4 is available only from 1963 Q2.

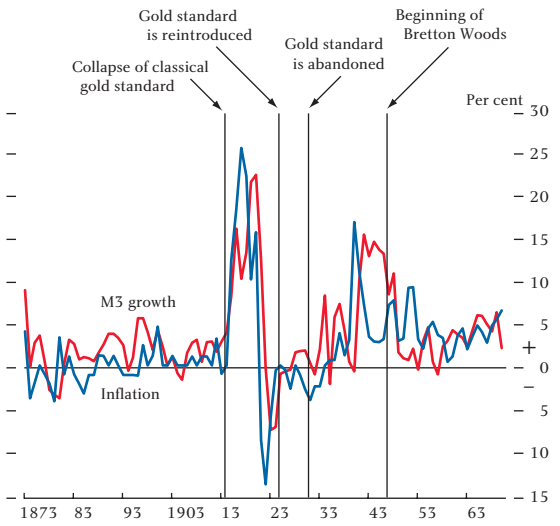
Chart 1
Inflation and money growth in the United Kingdom, raw data

(a) Composite price index[a] and M0 (annual rates of change)



(a) See O'Donoghue, Goulding and Allen (2004).

(b) Composite price index and M3 (annual rates of change)



(c) Retail price index and M4 (quarterly rates of change, annualised)

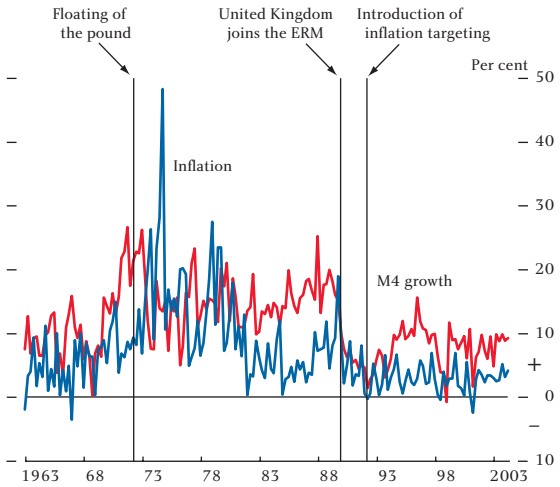


Table A
The correlation between money growth and inflation in the raw data[a]

Regime/period	*Correlation between π_t and Δm_t*		
	Contemporaneous	Lagged one year	Lagged two years
		Base money growth	
Gold standard	-0.04	0.07	0.51
Inter-war period	0.64	0.06	0.35
Bretton Woods	-0.03	-0.11	0.05
1972–92	0.69	0.69	0.80
Inflation targeting	-0.16	-0.27	0.01
		M3 growth	
Gold standard	0.34	0.00	0.40
Inter-war period	0.64	0.12	0.34
Bretton Woods	-0.14	-0.10	0.15
		M4 growth	
Bretton Woods	0.17	-0.14	0.02
1972–92	0.00	0.20	0.06
Inflation targeting	0.21	-0.12	-0.09

(a) Inflation and money growth have been computed as the log-difference of the relevant index.

Although well known,[1] changes over time in the correlation between inflation and the growth of monetary aggregates are, from a conceptual point of view, quite difficult to understand. A key tenet of the quantity theory of money is that the demand for money is a demand for real money balances, so it is not clear why the correlation between money growth and inflation should be so variable over time — indeed, the correlation essentially vanishes under regimes/periods lasting several decades. Irrespective of the specific direction of causality between money growth and inflation, we would expect over the longer term that money growth and inflation would be broadly in line with each other.

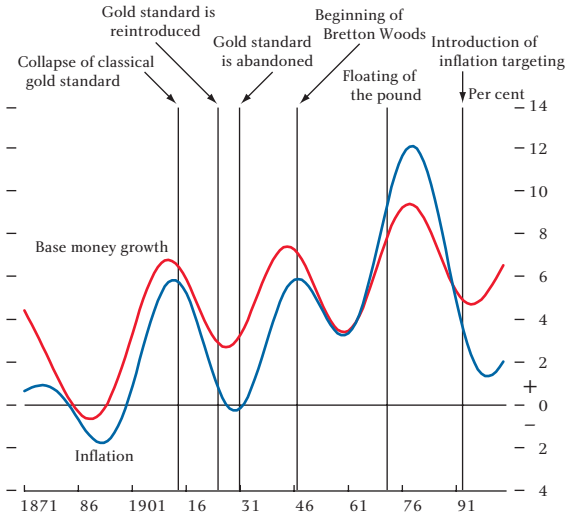
One possible explanation is that in a stable, low inflation environment — like the ones prevailing under the gold standard, Bretton Woods, and the current regime — shocks to the demand for money and real output become comparatively more important, thus blurring the correlation between money growth and inflation.[2] A second explanation is that the correlation may be different at different frequencies of data — Milton Friedman himself repeatedly stressed how the correlation between money growth and inflation may be different at the trend frequency, compared with the business-cycle frequencies. The failure to detect a stable correlation in the raw data may simply reflect the fact that, under certain regimes/periods, the correlations existing at the various frequencies tend to offset one another partly (or fully). In the next section we therefore proceed to an analysis of the correlation between money growth and inflation at different frequencies.

(1) Rolnick and Weber (1997), for example, report that '[...] under fiat standards, the growth rates of various monetary aggregates are more highly correlated with inflation [...] than under commodity standards'.
(2) This was originally noted by Estrella and Mishkin (1996).

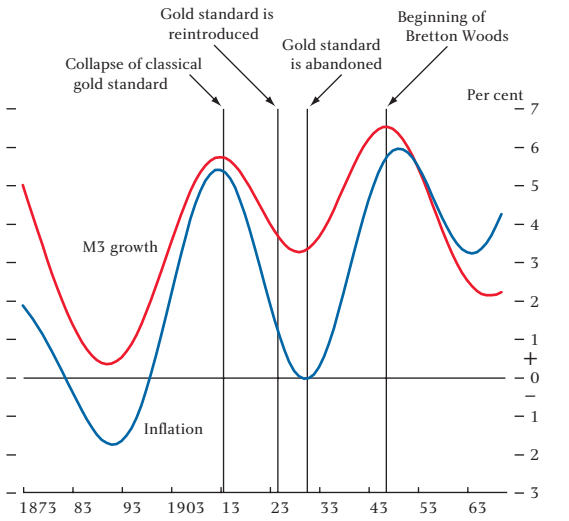
Chart 2
United Kingdom, low-frequency components of inflation and money growth

Components beyond 30 years

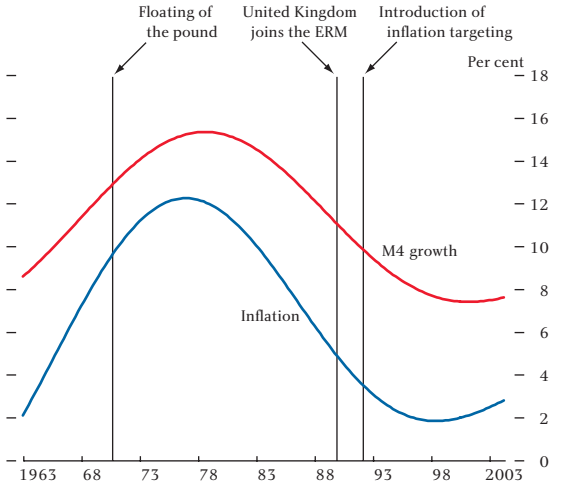
(a) Composite price index and MO (annual changes)



(b) Composite price index and M3 (annual changes)

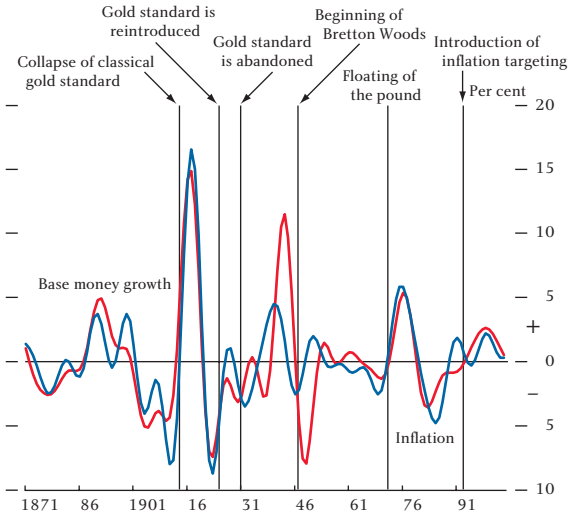


(c) RPI and M4 (annualised quarterly changes)

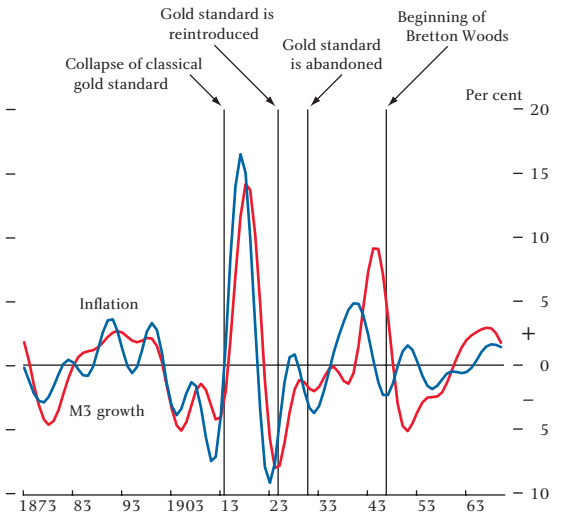


Components between eight and 30 years

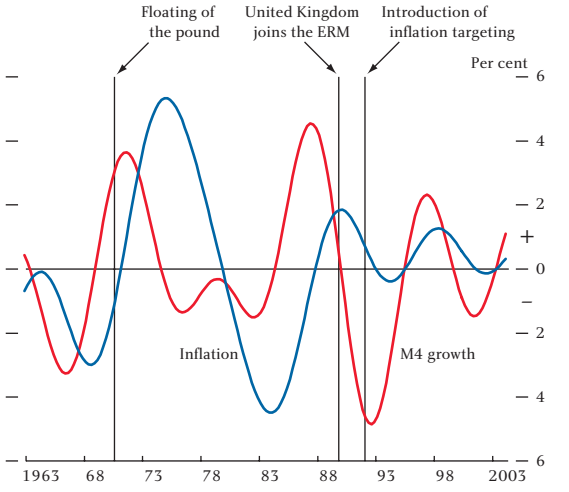
(d) Composite price index and MO (annual changes)



(e) Composite price index and M3 (annual changes)



(f) RPI and M4 (annualised quarterly changes)



An analysis by frequency components

Frequency-domain analysis offers a mathematically rigorous way of expressing the commonsense notion that (economic) time series contain components associated with different frequencies of oscillation: very slow-moving components, intuitively associated with the notion of a trend; fast-moving ones, associated with statistical noise and seasonal factors; and components 'in-between', traditionally associated with business-cycle fluctuations.(1)

Chart 2 shows, for the same series plotted in Chart 1, the components of those series with a time lag between two successive peaks (or troughs) beyond 30 years and between eight and 30 years, respectively.(2) These time lags are sometimes called the frequency of oscillation or periodicity of the series. Some facts are readily apparent, in particular:

(i) The components of inflation and money growth beyond 30 years have been systematically and very strongly positively correlated across all regimes.(3) This has held for both narrow and broad monetary aggregates, with the sole exception of base money under the current regime, for which the correlation has clearly been, so far, negative (-0.73). The unreliability of the estimates for the most recent quarters is unlikely to have driven this result:(4) as panel (a) of Chart 1 clearly shows, the same result is apparent, although weaker, even in the raw data.(5) However, the more general result of strong correlations between money growth and inflation across monetary regimes has the following important implication. In a classic paper, Lucas (1980) used linear filtering techniques to extract trend components from US M1 growth and CPI inflation over the period 1955–75, uncovering a near one-for-one correlation between the trends in the two series. He interpreted his evidence as:

> '[...] additional confirmation of the quantity theory, as an example of one way in which the quantity-theoretic relationships can be recovered via atheoretical methods from time-series which are subject to a variety of other forces [...].'
>
> In their criticism of Lucas (1980), McCallum (1984) and Whiteman (1984) pointed out how his results, being based on reduced-form methods, were in principle vulnerable to the Lucas (1976) critique, and as such they could *not* be interpreted as evidence in favour of the quantity theory of money. That is, Lucas' results could have depended, at least in principle, on the specific policy regime prevailing over his sample period. The UK experience proves, in this respect, invaluable: the fact that the correlation between the low-frequency components of inflation and the rates of growth of both narrow and broad money aggregates has remained so remarkably stable over such an extended period of time, encompassing radically different monetary regimes, strongly suggests such a correlation to be invariant to changes in the policy regime — ie to be structural in the sense of Lucas (1976).

(ii) Generally, the same holds for the frequency band between eight and 30 years. The exceptions are M4, for which the correlation does not exhibit any clear-cut stable pattern; M3 under Bretton Woods, for which the correlation turns negative; and base money around WWII and its immediate aftermath, when M0 growth markedly overshot, and then undershot, inflation.(6)

How should we interpret such stability across regimes in the underlying correlation between trend money growth and inflation? As stressed by Svensson (2003), the *meaning* to be attributed to the correlation between money growth and inflation depends on the nature of the underlying monetary regime.

(1) The filtering approach to business-cycle analysis was pioneered by Hodrick and Prescott (1997 — the paper was written in 1980, and remained unpublished for nearly two decades). Recent key papers in this literature are Baxter and King (1999), Stock and Watson (1999), and Christiano and Fitzgerald (2003).
(2) These components have been extracted via the algorithm described in Christiano and Fitzgerald (2003).
(3) However, components beyond 30 years are comparatively less precisely estimated than components associated with higher frequencies.
(4) In the filtering literature this is often referred to as the 'endpoint problem'. It originates from the fact that, due to the lack of future data, the decomposition into different frequency components for the most recent quarters is comparatively imprecise.
(5) One possible (partial) explanation for the recent strong growth in base money is that, as panel (a) of Chart 1 clearly shows, during the Great Inflation of the 1970s inflation mostly exceeded base money growth, resulting in a destruction of real M0 balances. In this light, the recent excess of base money growth over inflation may reflect, at least in part, the attempt on the part of economic agents to bring real M0 balances to a level closer to equilibrium.
(6) This last episode, however, lends itself to a simple explanation, namely the price controls in place around WWII, so that base money first markedly expanded, and then contracted, only partially affecting, in either case, the rate of inflation.

For example, in the extreme case of a pure monetary-targeting regime, the central bank perfectly controls the money supply. In that instance, money growth would be exogenous, while inflation would endogenously adjust to it. Under those circumstances, we could legitimately say that 'money growth causes inflation'.

By contrast, under a pure inflation-targeting regime in which the central bank perfectly controls inflation, the opposite would be true: inflation would now be exogenous, while money growth would endogenously adjust to it. Under those circumstances, one could argue that 'inflation causes money growth'. In general, however, 'money growth and inflation are both endogenous variables and there is no clear direction of causality'.(1)

However, the fact that the correlations between the trend components of inflation and money growth have remained so stable over long periods of time, encompassing radically different monetary arrangements (with the sole exception, so far, of base money growth under inflation targeting), suggests that such correlations find their origin in structural features of the economy that are largely independent of the underlying monetary regime.

A corollary of these findings is that any deviation between the trend components of inflation and money growth should necessarily be regarded as temporary. In the case of base money growth under the current regime, in particular, we can be confident that, with inflation expected to remain close to target, base money growth will progressively decline, reaching levels more in line with the targeted rate of inflation, the sustainable rate of growth of real GDP, and long-run trends in velocity.

Chart 3 shows, for base money and M4 growth, and for RPI inflation, the components with periodicities between six quarters and eight years, traditionally regarded in the business-cycle literature as the typical length of business cycles. The overall impression is of a much lower stability in the correlation than at the low frequencies. The correlation between M4 growth and inflation, in particular, has clearly been negative until the second half of the 1980s, after which it has become positive.

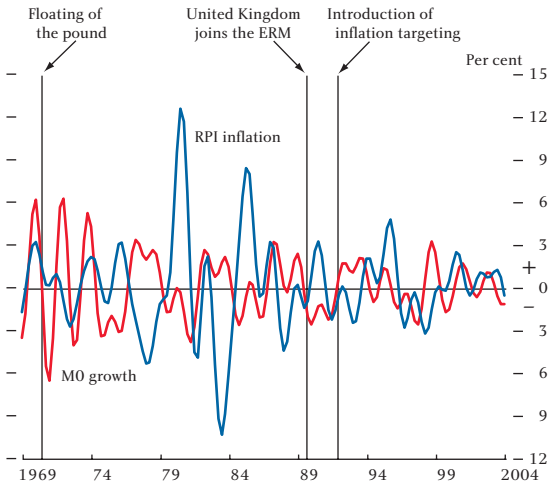
Evidence from the United States

If the stability of the correlation between inflation and the rates of growth of monetary aggregates at the very low frequencies reflects underlying features of the economy, we might expect to find similar evidence for other countries.

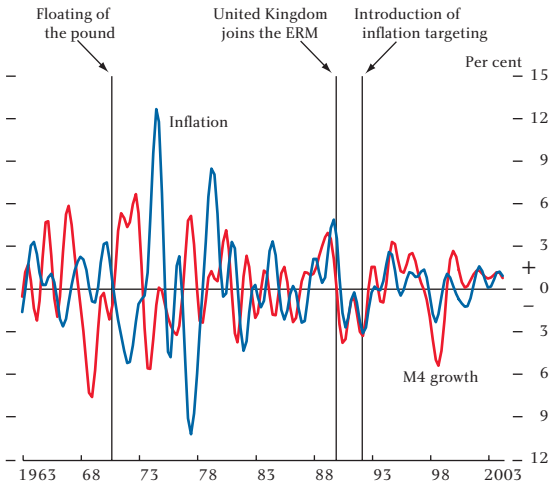
Chart 4 reports evidence for the United States since the second half of the 19th century for four monetary aggregates: base money, M1, M2, and the money stock aggregate preferred by Friedman and Schwartz (1963), defined as the sum of the currency held by the public and the deposits held at commercial banks. Specifically, the chart shows the components of inflation and the rates of growth of monetary aggregates with periodicities beyond 30 years, and is therefore exactly comparable to the top row of Chart 2 for the United Kingdom. This evidence broadly confirms, although in a less striking

Chart 3
United Kingdom, business-cycle components of inflation and money growth

(a) M0 growth and RPI inflation (annualised quarterly changes)



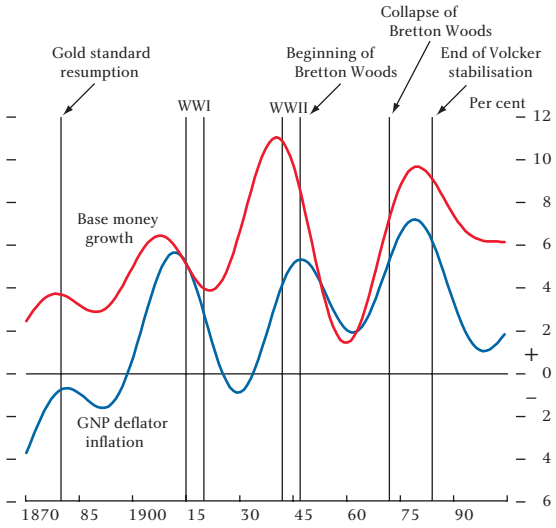
(b) M4 growth and RPI inflation (annualised quarterly changes)



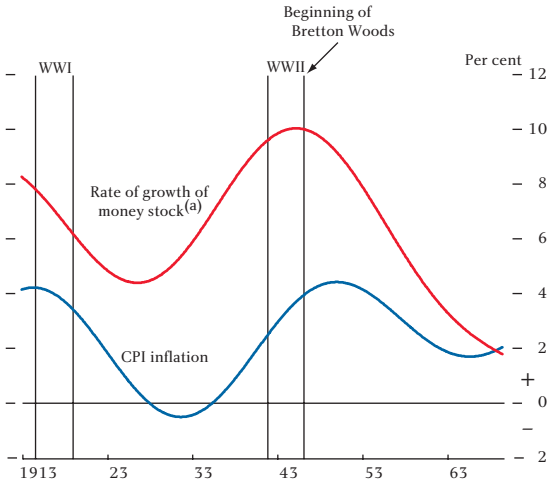
(1) Svensson (2003).

Chart 4
United States, low-frequency components of inflation and money growth

(a) Base money growth and GNP deflator inflation (annualised quarterly changes)

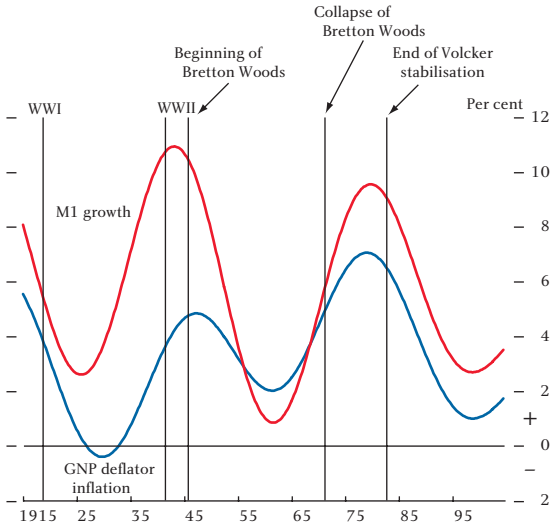


(b) Rate of growth of Friedman and Schwartz's (1963) money stock and CPI inflation (annualised quarterly changes)

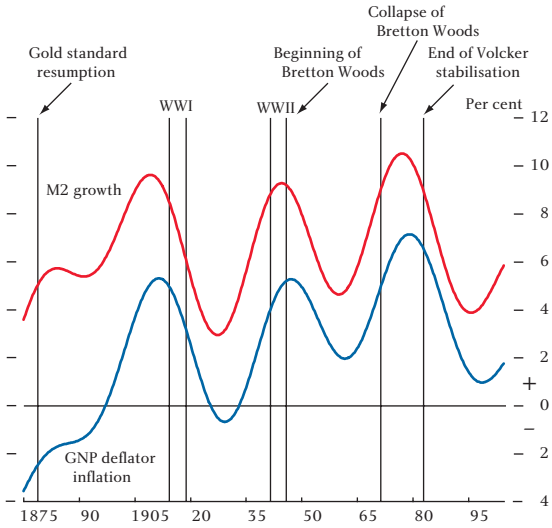


(a) Commercial banks plus currency held by the public.

(c) M1 growth and GNP deflator inflation (annualised quarterly changes)



(d) M2 growth and GNP deflator inflation (annualised quarterly changes)



way than for the United Kingdom, the overall stability of the correlation at the very low frequencies. In particular:

(i) we replicate Lucas' (1980) finding of a very high correlation between inflation and M1 growth at the very low frequencies, and show how it essentially holds for the entire span of available data.

(ii) In line with Christiano and Fitzgerald (2003), we detect a remarkably strong and stable correlation between inflation and M2 growth at the very low frequencies. Among all the aggregates we consider for the United States, overall M2 exhibits the greatest stability in its correlation with inflation.

(iii) During the gold standard, at the very low frequencies the correlation appears to have been very strong for both base money and M2.

Conclusions

In this article we have investigated the correlation between inflation and the rates of growth of narrow and broad money in the United Kingdom since the 19th century. Empirical evidence points towards a strong stability across monetary regimes in the correlation for longer-run trends in the data, but some instability in the short to medium term, including periods typically associated with the length of business cycles. Additional evidence for the United States confirms the overall stability of the correlation for longer-run trends in the data.

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The determination of UK corporate capital gearing

By Peter Brierley of the Bank's Financial Stability area and Philip Bunn of the Bank's MacroPrudential Risks Division.

This article seeks to explain the high current level of UK corporate capital gearing. It also explores the empirical relationship between gearing and a range of financial characteristics. Analysis of aggregate data suggests that the sharp rise in gearing between 1999 and 2002 cannot all be explained by an increase in its long-run equilibrium level, according to a model where that equilibrium is determined by the trade-off between the tax benefits of debt and the risks of financial distress. There are a number of factors not captured by that model that could have contributed to a sustainable increase in gearing. But on balance it seems that gearing has been above a sustainable level, causing firms to adjust their balance sheets by paying lower dividends and issuing more equity and perhaps by investing less than they otherwise would have done. Analysis of company accounts data suggests that gearing levels are persistent, positively related to company size and negatively correlated with growth opportunities and the importance of intangible assets. In the past, highly profitable companies had low gearing, but this relationship has broken down since 1995 as more profitable firms have increased their debt.

Introduction

Corporate capital gearing is a measure of the net indebtedness of the corporate sector. It rose sharply in the late 1990s and remains at an historically high level, although it has fallen back from the peak seen in 2002. Substantial research and analysis has been carried out by the Bank and other researchers over the past few years into the behaviour and determinants of corporate gearing. This article reports on that work, places it in the context of the extensive literature on corporate capital structure and assesses the extent to which it can explain why corporate gearing is currently so high.

High levels of corporate gearing are of interest because they have important implications for both financial and monetary stability. Other things being equal, rapid growth of borrowing increases the probability of the corporate sector facing difficulties in servicing its debt, thereby raising the expected rate of corporate liquidations and the likelihood of losses for the financial sector. And any attempt by companies to reduce their indebtedness by cutting back real expenditures has implications for aggregate demand and hence for the achievement of the inflation target.

This article begins by discussing recent trends in corporate gearing. It goes on to give a brief overview of the main theories of corporate capital structure that have been developed in the literature. We then look at empirical work carried out at the Bank to explain corporate gearing and the extent to which this can account for recent developments. Finally, the relationship between gearing and various characteristics of companies is explored.

Recent trends

Two aggregate series on UK corporate capital gearing can be calculated from data published by the Office for National Statistics (ONS). The first of those series assesses corporate indebtedness in relation to the market value of UK companies (the market value measure). The second compares indebtedness with the cost of replacing the corporate sector's capital stock (the replacement cost measure). Chart 1 shows the evolution of the market value and replacement cost measures since 1970 for the private non-financial corporate (PNFC) sector.(1)(2)

On both measures, capital gearing is currently at high levels by historical standards. Over much of the 1990s,

(1) Wider measures of the corporate sector's gearing, or its 'economic leverage', would also need to take into account other debt-like corporate sector obligations, such as those relating to pension-fund liabilities and leases.
(2) The large spike in capital gearing at market value in 1974 is a result of stock market volatility over that period.

net debt rose broadly in line with the capital stock measured at replacement cost. Rising equity markets during this period meant that capital gearing at market value fell modestly. But both measures of capital gearing rose markedly around the turn of the century. This increase coincided with low and falling interest rates, the boom in mergers and acquisitions in 1999–2001 and a surge in borrowing by telecommunications companies associated with the bidding for third-generation (3G) mobile phone licences. Weak equity markets post-2000 resulted in larger increases in the market value measure of corporate gearing than in the replacement cost measure. Over the past two years, capital gearing has begun to fall back again, especially on the market value measure, as equity prices have started to recover and firms have begun to adjust their balance sheets. However, capital gearing remains at historically high levels.

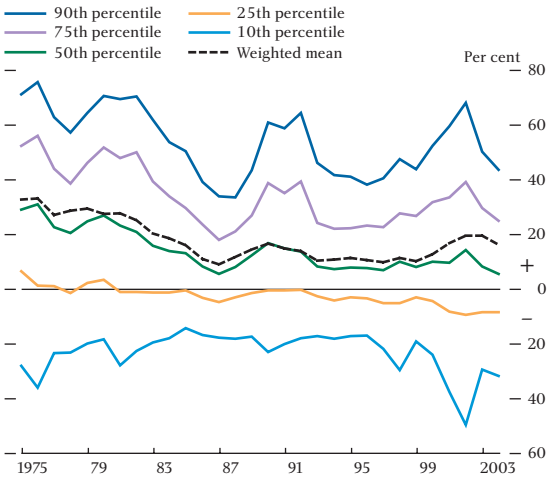
Chart 1
Aggregate capital gearing of UK companies(a)

Sources: ONS and Bank calculations.

(a) Private non-financial companies. Data before 1987 are based on discontinued series.

Information on trends in corporate gearing is also available from company accounts data, which permit analysis of the distribution of gearing across companies. Chart 2 shows the distribution of capital gearing at market value over the period 1975–2004 for quoted non-financial UK companies.(1) From these data it appears that gearing for most individual companies is not currently at historically high levels. In particular, the rise in gearing in the late 1990s appears more moderate than suggested by the aggregate ONS measures and has been concentrated among the most heavily geared firms. But the company-level data concur with the aggregate data in suggesting a reduction in gearing across the distribution in the recent past.

Chart 2
Distribution of corporate capital gearing(a)(b)



Sources: Thomson Financial Datastream and Bank calculations.

(a) Market value measure. The 90th, 75th, 50th, 25th and 10th percentiles are shown by the solid lines, moving from the most to the least geared companies. The broken line is a weighted mean that is calculated as the sum of net debt of all firms divided by the aggregate market valuation of their capital.
(b) The capital gearing calculation uses net debt, so firms who have more cash than debt will have negative gearing.

Chart 2 also shows a weighted average of corporate gearing, which has risen by more than median gearing since the late 1990s. This weighted measure is dominated by very large companies with substantial amounts of debt in absolute terms, and it more closely follows the profile of the aggregate measures calculated from ONS data. Company accounts information suggests that it is those large firms that have raised their gearing most rapidly since the mid-1990s; smaller firms' gearing has risen by less, remained stable or fallen (see the section below which examines the relationship between gearing and company size). Given that the very large companies represent a small minority of the sample, the build-up of their gearing would be less apparent from looking only at the median and other summary percentiles in the distribution, which are not weighted.

The concentration of debt among large firms is crucial in assessing the implications of rising corporate indebtedness for financial stability. The largest quartile of quoted companies ranked by market capitalisation (which roughly corresponds to the FTSE 350) accounted for an average of 92% of the net debt of all quoted non-financial companies between 1975 and 2004; in

(1) At the individual firm level, we focus only on capital gearing at market value rather than replacement cost, given the difficulty in accurately measuring the true value of the replacement cost of the capital stock for each firm using the perpetual inventory method.

2004 this proportion was 97%. Indeed, the largest decile (corresponding roughly to the FTSE 100) accounted for 84% of net debt in 2004. Smaller than average firms currently have only 1% of the whole sample's net debt, and this proportion has been falling in recent years. It follows that any assessment of the risks to the financial sector arising from recent rapid increases in corporate gearing and of the implications for monetary stability of subsequent corporate sector adjustment needs to focus mainly on the behaviour of the largest companies.

Empirical evidence

This section discusses empirical work carried out at the Bank and investigates the extent to which the models described in the box on page 359 can account for the current high level of capital gearing. It begins by looking at aggregate-level work before moving on to summarise firm-level analysis and to investigate the relationship between gearing and some key financial characteristics.

(i) Bank empirical work at the aggregate level

The Bank's empirical work on aggregate corporate gearing is based on the trade-off model (see Bunn and Young (2003 and 2004) and described in the box on page 359, extending the approach taken in earlier work by Young (1996)). The trade-off model is used to estimate a target level of gearing. That can be compared with the actual value, to see whether gearing appears to be above its long-term equilibrium level.

Table A
Aggregate equation for net debt of UK corporate sector

Estimated coefficients
Dependent variable: $\Delta 1n$ (net debt)

		Coefficient	T-ratio
Constant		0.253	4.66
1n (capital gearing at market level)	$t-1$	-0.078	-4.38
$\Delta 1n$ (market valuation)	t	0.073	1.50
$\Delta 1n$ (market valuation)	$t-1$	-0.177	-3.78
Tax gains from gearing	t	2.085	2.30
Corporate liquidations rate	t	-0.014	-1.69
Q1 dummy	t	0.035	3.37
1981 Q2 impulse dummy	t	-0.175	-3.57
1987 Q1 impulse dummy	t	0.137	2.74
1990 Q1 impulse dummy	t	0.201	4.10

Long-run solution
Dependable variable: 1n (capital gearing at market value)

Constant	2.88
Tax gains from gearing	26.61
Corporate liquidations rate	-0.18

Note: The estimated equation has an R^2 of 0.48 and passes all of the standard diagnostic tests. Estimation is by OLS using quarterly data from 1970 Q1 to 2003 Q3. See Bunn and Young (2004) for more details of the definitions.

Table A reports the estimated equation that links the change in corporate net debt to lagged gearing (at market value), changes in the market value of the corporate sector, the tax benefits of gearing and the liquidations rate (proxying for the risks of financial distress associated with debt). The motivation for this equation is to test empirically the hypothesis that increases in debt are greater when there are significant tax advantages associated with raising debt levels and/or a low risk of financial distress from those higher debt levels, as suggested by the trade-off theory. The tax benefits of gearing have a positive effect on debt that is significant at the 5% level, while the liquidations rate has a negative effect which is significant at the 10% level.

In the short run, a variety of different factors can affect corporate gearing. But in the long run, the equation reported in Table A implies a relationship between gearing and the tax benefits of debt (with a positive effect) together with the risk of bankruptcy (with a negative effect). This can be interpreted as a long-run equilibrium or a target level of gearing, and it provides empirical support for the trade-off theory. Chart 3 plots this implied equilibrium level of gearing alongside the actual level.(1) It shows that the rise in capital gearing since the late 1990s cannot be accounted for by the long-run equilibrium level of gearing implied by this particular model, although this has increased modestly in recent years, largely reflecting low and falling corporate liquidations.

Chart 3
Actual and implied long-run equilibrium capital gearing(a)

Sources: ONS and Bank calculations.

(a) Private non-financial companies.

(1) The aggregate gearing measures shown in Charts 1 and 3 are those reported in recent issues of the *Financial Stability Review*. These differ from those used in Bunn and Young (2004) because our preferred definition of debt has been slightly widened to incorporate finance leasing and loans from institutions other than banks. A minor adjustment is also made to the market valuation of PNFCs. The long-run equilibrium level of gearing shown in Chart 3 has also been adjusted accordingly.

Theories of corporate financial structure

The modern literature on corporate capital structure dates back to Modigliani and Miller (1958), who showed that, in a perfect capital market, the value of a company is independent of its capital structure. In such a world, there is no optimal capital structure. Much of the subsequent discussion in the literature has focused on the implications of capital market imperfections. One such imperfection is the existence of taxes. In the United Kingdom, as in most other developed countries, corporate debt interest payments are tax-deductible, which implies that firms can reduce their tax liability by additional borrowing. They can then pay out the additional funds to shareholders as dividends who can invest the proceeds and earn a return, although the size of this benefit also depends on the tax regime faced by shareholders. Debt finance is consequently more tax efficient for the company and its shareholders than equity finance because it is better for the firm to borrow than for shareholders to borrow and supply equity capital to the firm. The **trade-off model** of corporate gearing postulates that firms will aim for target or 'optimal' gearing levels that balance (ie trade off) the tax benefits of additional debt against the expected costs of the financial distress that becomes more likely as indebtedness rises (Barclay *et al* (1995), Myers (2001)).

The literature also extends the benefits of debt finance to include non-tax factors. In particular, costs may result if the debt market is characterised by information asymmetries between lenders and borrowers. Managers may seek to exploit these asymmetries by raising equity only when they view the company's shares as overvalued. Investors will consequently discount any new and existing shares when a new equity issue is announced. The **pecking order model** was developed by Myers and Majluf (1984), who argued that managers will try to avoid the resulting risk that profitable investment projects will be foregone by seeking to finance them internally. If retained earnings are insufficient, they will opt for debt rather than equity finance, because debt providers, with a prior claim on the firm's assets and earnings, are less exposed than equity investors to errors in valuing the firm. Managers will only opt for equity finance as a last resort in this model. In these circumstances, corporate gearing will reflect a company's need for external funds and — unlike with the trade-off approach — there will not necessarily be any target or optimal level of gearing.

The agency costs arising from the separation of ownership and control may exacerbate information asymmetries by inducing conflicts of interest between a company's managers, shareholders and creditors, based on differing incentives. In the **agency cost models** of gearing initiated by Jensen and Meckling (1976), managers have other objectives, which may involve wasteful usage of the company's free cash flow. One of the advantages of debt is that it limits free cash flow available to managers, although investors may seek to limit agency costs by monitoring managers or putting them on compensation packages that align their interests more closely with those of investors.

In recent years, a new approach to the determination of corporate gearing has developed from the financial contracting literature associated with Hart (1995 and 2001). This **'control rights' model** tends to focus on small entrepreneurial firms, in which owner-managers prefer debt to equity because they do not wish to cede control rights to outside investors.

So why might capital gearing have risen so rapidly in the early years of the new century? Aside from possible special factors such as 3G-related telecoms borrowing, there are a number of factors that are not explicitly included within this model (and therefore are implicitly assumed to be constant) that may help to explain an increase in the true target level of corporate gearing. The shift to a more stable, low inflation, low nominal interest rate macroeconomic environment will have reduced the probability of firms suffering financial distress; this may not be adequately captured by the simple proxy in the model. A shift in the inflation environment may also have reduced the real cost of debt finance if it has been accompanied by a shift in the inflation risk premium. Also lower interest rates make high debt levels easier to service and to sustain for a longer period of time.

Bunn and Young (2003 and 2004) investigate ways in which companies adjust their balance sheets when gearing deviates from the implied long-run equilibrium level. They find that a positive gap between actual and long-run equilibrium gearing induces companies in aggregate to pay lower dividends than they would otherwise have done and/or issue more equity (assuming market conditions are favourable). This strengthens the empirical support for the trade-off theory, because it shows that firms adjust their behaviour in response to deviations from the target. The effect on gross investment, although negative as predicted by theory, is not robustly statistically significant.(1) The speed of adjustment is found to be slow, not surprisingly given that the flows of dividends and net equity finance are small relative to the stock of debt. This work does not test for other possible forms of corporate adjustment, such as through reduced expenditure on inventories or cutbacks in the number of employees or in hours worked.

(ii) Empirical work at the company level

The estimated relationships discussed so far are derived from aggregate data. Work has also been carried out at the company level to estimate equations for dividends, the propensity to issue equity and investment. These merely include actual gearing as an explanatory variable (among other factors) rather than gearing relative to its target level (see Benito and Young (2002)). But if each firm's target is stable, or if changes in targets over time are common across firms, then all of the variation in actual gearing picks up variation in gearing relative to target. Internal Bank work has recently re-estimated the key equations from Benito and Young (2002); these results are summarised in Table B.

Table B
Company-level equations for dividends, investment and equity issuance

		Dividends		Investment		Equity issuance (probit model)	
		Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Income gearing	$t-1$	-0.394	-4.28	-0.091	-6.50		
Capital gearing at replacement cost (using net debt)	$t-1$	-0.191	-5.62	-0.048	-2.67		
Capital gearing at replacement cost (using gross debt)	$t-1$					0.685	6.99
Other controls		Lagged dependent variable, cash flow, investment, Q, real sales, year effects		Lagged dependent variable, cash flow, investment, Q, sales to capital, year effects		Cash flow, cash holdings, investment, Q, real sales, year effects	

Note: Dividends and investment equations are dynamic panel data models estimated using the GMM-SYSTEM estimator, the equity issuance equation is a random effects probit model where a firm is defined as making an issue if it issues shares for cash in excess of 2% of market capitalisation. Dividends are scaled by sales; cash flow, cash holdings and investment are all scaled by the capital stock. The data are a panel of 652 firms with 8,751 firm-year observations between 1980 and 1998.

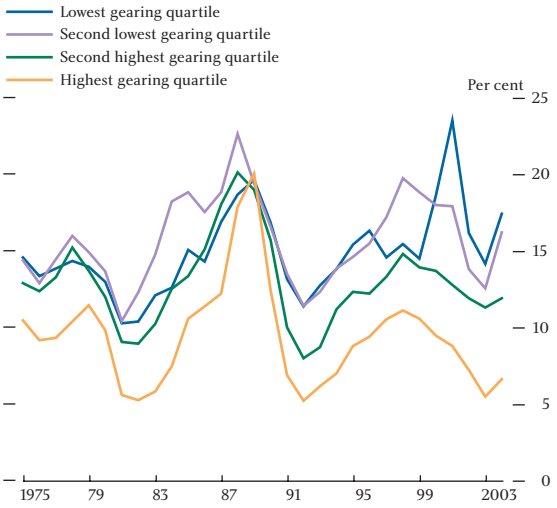
The company-level results provide broad support for the plausibility of the aggregate equations. They suggest that high levels of gearing have a negative impact on dividend payouts and increase equity issuance. Capital spending is found to be significantly adversely affected by the cost of servicing debt. But, even after controlling for this, there is a statistically significant negative relationship between capital gearing and investment. To reconcile this with the weaker aggregate result, it may be that debt only constrains the investment of the most highly geared firms, so it is difficult to pick up this effect in a robustly significant way using aggregate data. Chart 4 supports this argument; though it does not hold other balance sheet factors constant as the econometric analysis does, it shows that the most highly geared quartile of firms have persistently invested less than firms with lower gearing over the past 30 years.

The implications from this work on balance sheet adjustment are that dividends will be lower and equity issuance higher than they would have been if there was no constraint from high gearing levels. High gearing levels may also be acting as a constraint on investment for the more highly geared firms. The corporate sector has now been in financial surplus for the past 13 quarters following the peak in gearing, which

(1) In a broadly specified investment equation the deviation between actual and implied equilibrium capital gearing is only significant at the 30% level, although this can be improved by restricting the sample period and adjusting the equation specification. See Bunn and Young (2004) for further details.

suggests that this balance sheet adjustment has already been taking place.

Chart 4
Median investment as a percentage of the capital stock by capital gearing quartile(a)



Sources: Thomson Financial Datastream and Bank calculations.

(a) Median investment as a percentage of the capital stock for quartiles of companies ranked by their capital gearing at market value in each year.

From a financial stability perspective, separate empirical work in the Bank has found that it is the cost of servicing debt rather than the level of capital gearing itself which is the key determinant of corporate liquidations in aggregate.(1) As interest rates are currently low and corporate profitability robust, debt servicing costs are low by historical standards. Providing current conditions persist, this implies that the existing high gearing levels do not pose a major financial stability risk, although they do increase the vulnerability of the corporate sector to a significant rise in interest rates or fall in profitability.

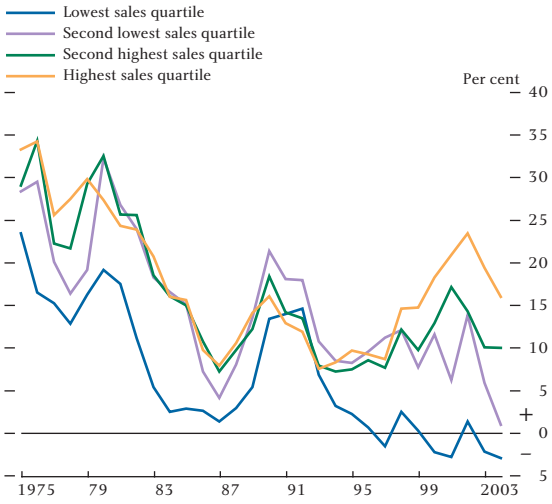
(iii) Corporate gearing and company characteristics

An alternative approach to comparing the empirical relevance of the different models is to investigate how gearing is related to particular characteristics of companies. This may provide a useful insight into the firms that have been primarily responsible for the movements in gearing at the aggregate level, and whether the firms who are more highly geared are better placed to be able to sustain those debts. It may also help to discriminate between the competing theories of corporate capital structure by considering the implications of the different theories for the relationship between gearing and company characteristics and assessing whether these relationships hold in the actual data.

(a) Company size

The effect of company size on gearing is unclear theoretically. Larger firms tend to enjoy more diversified income streams and a lower volatility of earnings; as such, they may face a lower risk of bankruptcy, which should point to a positive relationship between gearing and size. Indeed, this would be predicted by both the trade-off and pecking order approaches: in the former, the lower risks of distress would push up optimal gearing, while in the latter, the lower volatility of earnings and lower costs at which larger firms can access debt markets should also tend to raise gearing. But at the same time, larger firms tend to be subject to less acute information asymmetries, given that more published information is generally available to investors. This may mean that larger firms face fewer difficulties in raising equity relative to debt finance. Other things equal, that might suggest a negative relationship between gearing and size.

Chart 5
Capital gearing by sales quartile(a)



Sources: Thomson Financial Datastream and Bank calculations.

(a) Median capital gearing at market value of quartiles of companies ranked by sales in each year.

The empirical evidence points to a positive relationship. The effect is small and uncertain in some studies (see Barclay *et al* (1995)), but well-determined in others (see Fama and French (2002)). In an international comparison, Rajan and Zingales (1995) find evidence of a significant positive relationship in most of the G7

(1) Recent work on modelling aggregate corporate liquidations is discussed in Bunn, Cunningham and Drehmann (2005).

countries. Company accounts data for UK-quoted companies provide some support for this, although the evidence is not conclusive. If companies are grouped by sales, the quartile with the lowest turnover has persistently lower median gearing than the other three quartiles throughout nearly all of the 1975–2004 period (Chart 5). The gearing of these other quartiles moved in a similar way up to the mid-1990s, since when (as noted earlier) the gearing of the largest firms has risen most rapidly, to move above that of the other groups. Given the dominant role of these firms in the aggregate statistics, the increase in aggregate gearing since the late 1990s can be explained by large firms leveraging up. This increase in debt concentration is important in informing surveillance of financial stability risks in the corporate sector. It is perhaps reassuring, because large companies generally have a lower probability of default than smaller firms, although should large firms get into financial difficulty the systemic consequences are potentially greater.

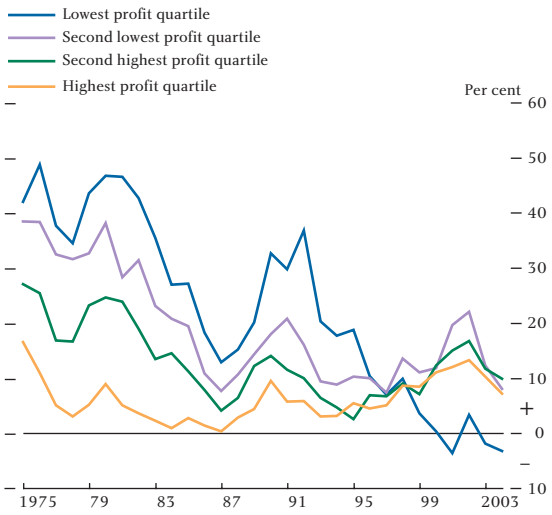
(b) Profitability

The pecking order model clearly suggests that there should be a negative relationship between gearing and profitability. By contrast, the trade-off model points to a positive relationship, given that the tax benefits of debt would tend to increase and the costs of financial distress decrease as profits rise. A positive relationship is also implied by agency cost models, in which gearing disciplines managers of more profitable firms to commit larger fractions of earnings to debt interest payments.

Empirical evidence tends to support the pecking order model's prediction of a negative relationship between corporate gearing and profitability (see, for example, Titman and Wessels (1988), Rajan and Zingales (1995) and Fama and French (2002)). Chart 6 shows median capital gearing at market value of four groups of UK-quoted non-financial companies ranked by profitability. Between 1975 and 1995 there was evidence of a clear negative relationship between gearing and profitability, but this has broken down in recent years as the least profitable firms have become less highly geared and more profitable companies have increased their leverage. One explanation is that the least profitable companies have been deterred from borrowing because their earnings have fallen to levels that are insufficient to service higher debts.(1)

From a financial stability viewpoint, the recent rise in gearing among the more profitable firms and fall in gearing at the least profitable firms is reassuring, since the more profitable the firm (other things equal) the more able it is to sustain higher levels of debt. The more profitable companies also tend to be the larger firms that were identified above.

Chart 6
Capital gearing by profitability quartile(a)



Sources: Thomson Financial Datastream and Bank calculations.

(a) Median capital gearing at market value of quartiles of companies ranked by their operating profit margin in each year.

(c) Growth opportunities

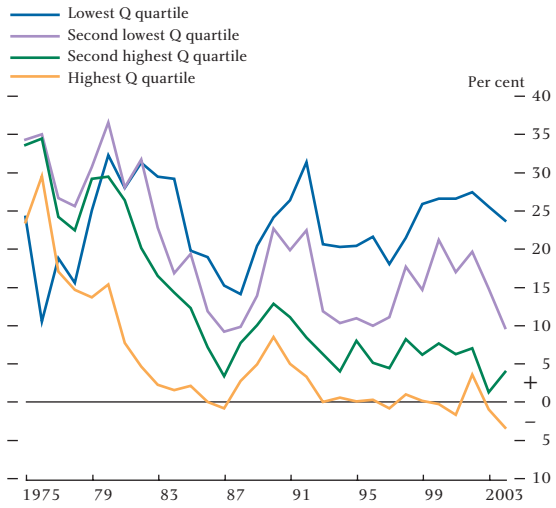
Theory suggests that separate considerations apply to the capital structure of high-growth companies with substantial investment opportunities. Such companies should aim for low gearing now because the opportunity cost of not being able to finance valuable future investment opportunities is greater than for a firm which does not expect to have such profitable opportunities. Agency cost models would suggest that such companies also have less need for debt to control free cash flows. On the face of it, the higher investment requirements of these companies should lead to higher gearing in the pecking order model, but Fama and French (2002) proposed a dynamic version of the pecking order, where firms currently maintain more low risk debt capacity in order to finance greater expected investment in the future. In such a model, high-growth firms would again have low current gearing.

Growth opportunities are generally proxied in empirical studies by the ratio of the market value of the company's assets to their book value. Most of these studies, notably

(1) These are generally small companies who are particularly concentrated among technology-based industries.

those by Barclay *et al* (1995), Rajan and Zingales (1995), Fama and French (2002) and most recently Hovakimian *et al* (2004), support the theory in finding strong evidence of a negative relationship between gearing and market to book ratios. UK company accounts data lend clear support to these empirical findings: Chart 7 shows that companies with the highest (lowest) levels of Tobin's Q (one proxy for the market to book ratio) had the lowest (highest) gearing for most of the 1975–2004 period.

Chart 7
Capital gearing by Tobin's Q quartile(a)



Sources: Thomson Financial Datastream and Bank calculations.

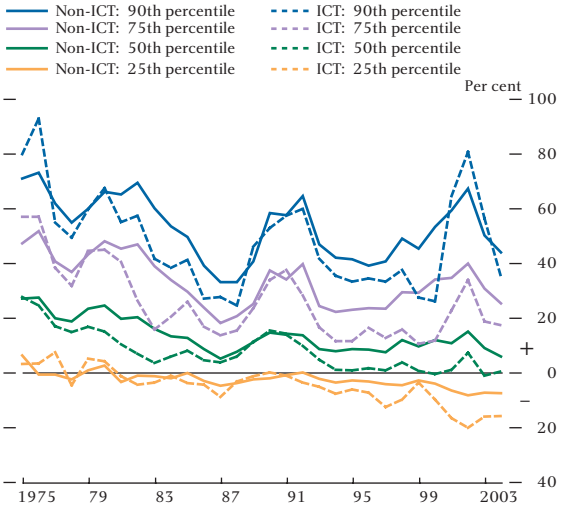
(a) Median capital gearing at market value of quartiles of companies ranked by Tobin's Q (ratio of market value of capital stock to replacement cost) in each year.

The Bank's work on the financing of technology-based small firms, summarised in Brierley (2001), finds that debt finance is less important than equity finance for high-tech firms. Given that high-tech firms are likely to have stronger growth opportunities than small firms in general, this is consistent with a negative relationship between gearing and growth opportunities. Chart 8 shows that capital gearing of companies in the information, communications and technology (ICT) sector has generally been lower than that of non-ICT companies across the distribution for most of the period between 1975 and 2004.

(d) Tangibility of assets

The consensus in the literature is that, other things being equal, the greater a firm's dependence on intangible assets (such as patents), the lower should be its target and actual gearing. Firms with low proportions

Chart 8
Distribution of capital gearing of ICT and non-ICT companies(a)(b)



Sources: Thomson Financial Datastream and Bank calculations.

(a) Market value measure. The 90th, 75th, 50th and 25th percentiles are shown, solid lines represent the distribution for non-ICT firms, and broken lines show the distribution for ICT companies. The 10th percentile is omitted to reduce the height of the y-axis and improve the readability.
(b) ICT sector is defined as the Thomson Financial Datastream sectors: computer hardware, computer services, consumer electronics, electrical equipment, electronic equipment, internet, telecom equipment, telecom fixed line and telecom wireless.

of tangible assets (that is, physical assets such as property, vehicles and machinery) are likely to face relatively high bankruptcy costs, given that they can only offer limited collateral to secure their debt finance, and so will tend to have low levels of target gearing according to the trade-off theory. The lack of collateral also raises the agency costs of debt relative to equity finance, so such firms should also have relatively low gearing under the pecking order approach. This is borne out by UK company accounts data for the quoted sector, which confirm that capital gearing has generally been positively related to capital intensity (the ratio of fixed to current assets(1)), and therefore inversely related to the importance of intangible assets, since the mid-1980s (Chart 9). This is reassuring for financial stability as it suggests that it is principally the companies with most collateral available to secure their debt that have raised gearing to historically high levels in recent years.

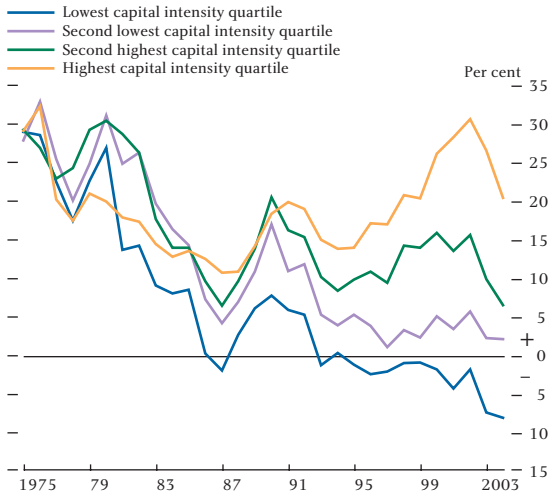
(e) Persistence in gearing levels

These relationships between gearing and various financial characteristics of companies may help to explain the persistent manner in which gearing levels appear to vary across industries, although there can also be substantial dispersion between different firms in the

(1) Current assets are defined as assets that can be converted into cash within one year.

same industry. UK company accounts data indicate that industries with persistently high gearing include hotels, house builders, restaurants and pubs, transportation, vehicle distribution and water, while examples with low gearing include the media, pharmaceutical, retailing and, as noted above, IT/high-tech industries. This persistence in gearing levels in certain industries may reflect common company-level characteristics with systematic links to target gearing levels, for example (as already noted) the ratio of tangible to intangible assets.

Chart 9
Capital gearing by capital intensity quartile(a)



Sources: Thomson Financial Datastream and Bank calculations.

(a) Median capital gearing at market value for quartiles of company ranked by capital intensity (ratio of fixed to current assets) in each year.

Persistence in gearing also reflects the fact that the flows used to adjust balance sheets are relatively small in relation to the stocks being adjusted, which means that adjustment is likely to be a protracted process. Consistent with this, Benito and Young (2002) find that the coefficient on the lagged dependent variable in a simple autoregression (AR(1)) for corporate gearing using a panel of UK companies is of the order of 0.6. In other words, the level of a firm's gearing today is heavily influenced by its level in the recent past. This persistence in gearing has important financial stability implications because it illustrates that firms may not be able to adjust their debt levels easily in response to shocks. For example, were interest rates to rise sharply, debt levels could not be quickly reduced, implying an increase in debt-servicing costs in the short run and consequently a rise in bankruptcy risks.

Persistence in gearing does, however, tend to erode over time. A one-year transition matrix for UK-quoted companies shows that, over the period 1975–2004, 73% of companies ranked in the highest gearing quartile in any one year remained in that quartile in the following year (Table C). That proportion falls to 40% in the ten-year transition matrix.

Table C
Capital gearing one and ten-year transition matrices(a)(b)

		Group in t			
		1	2	3	4
Group in $t-1$	1	73	19	5	3
	2	18	56	22	4
	3	5	21	54	20
	4	3	4	19	73
Group in $t-10$	1	45	24	17	14
	2	24	30	26	19
	3	16	26	31	27
	4	15	19	26	40

Sources: Thomson Financial Datastream and Bank calculations.

(a) Market value measure. One-year transition probabilities are based on a sample of 32,525 firms with capital gearing data in year t and year $t-1$, the ten-year probabilities use 12,584 firms with observations in t and $t-10$.
(b) The groups one to four run from the least to the most-geared companies.

Conclusions

Our approach to modelling corporate gearing in empirical work at the aggregate level is based on the trade-off model, in which companies target a long-run equilibrium gearing ratio that is determined by the tax benefits of gearing relative to the risks of financial distress. This work suggests that the equilibrium level of gearing has been relatively stable over the past decade, and the sharp rise in UK corporate gearing between 1999 and 2002 to historically high levels cannot be explained by a substantial rise in the target. It may partly reflect special factors, beyond the scope of the model, such as borrowing by telecoms companies to acquire 3G mobile phone licences. And the shift to a more stable, low inflation, low interest rate macroeconomic environment may have increased the true target level of gearing by more than our estimate. Low interest rates allow firms to remain above their equilibrium gearing for longer, given that the costs of servicing high debt levels are likely to be relatively low.

The implication of gearing being above the long-run equilibrium level is that companies will seek to adjust their gearing back towards target over time, but that this process will be protracted. The initial stabilisation and subsequent modest fall in gearing since 2002, along with the corporate sector maintaining a financial surplus over this period, supports this interpretation, as does the fact that gearing levels tend to be persistent, with the degree of persistence declining over time. The work suggests that the adjustment will occur partly through reductions in dividend payouts and partly through increases in equity issuance. Less evidence is found that

investment spending will be cut back solely in response to balance sheet pressure at the aggregate level, although empirical work at the firm level has shown stronger support for this possibility.

The aggregate model cannot be used directly to test between models of corporate gearing postulated in the literature, not least because the assumptions underlying the pecking order, agency cost and control rights theories are less amenable to quantification. It seems unlikely that corporate capital structure can be fully explained by any one theory, especially given that the theories are not mutually exclusive.

Evidence from UK accounts-based data for quoted companies suggests that gearing has been persistently negatively related to growth opportunities and the importance of intangible assets in balance sheets over the past 30 years. There also seems to be a negative relationship between gearing and profitability over the bulk of this period. But that relationship appears to have broken down since 1995, as unprofitable firms have scaled back gearing and more profitable firms have leveraged up. The relationship between gearing and company size appears to be broadly positive, especially in the recent past when the rises in gearing have been concentrated among large companies.

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Publication of narrow money data: the implications of money market reform

By Norbert Janssen of the Bank's Monetary and Financial Statistics Division and Peter Andrews of the Bank's Monetary Assessment and Strategy Division.

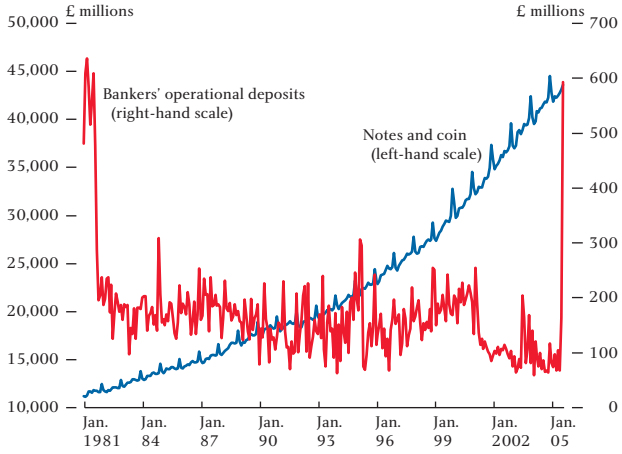
The published M0 series comprises notes and coin in circulation and bankers' operational balances at the Bank of England, with the latter accounting for a very small part of the whole. As part of the money market reforms to be introduced in 2006, banks and building societies will be able to hold interest-bearing reserve accounts at the Bank of England that will be much larger than their former operational balances. After the reform, the Bank plans to discontinue publication of M0 and instead publish separate series for notes and coin in circulation and banks' and building societies' reserves.

Narrow money

Each month, the Bank of England publishes data on two measures of narrow money: notes and coin, and M0.(1) The former measure comprises sterling notes and coin in circulation outside the Bank of England (and therefore includes those held in banks' and building societies' tills), and the current definition of M0 adds bankers' operational deposits held at the Bank of England to the notes and coin series. The origins of M0 as a measure of narrow money (discussed in the box on pages 370–71) date back to March 1981, when it was described as the (wide) monetary base.(2) The original definition of the monetary base distinguished three elements: notes and coin in circulation with the public; banks' till money (or vault cash); and bankers' deposits (other than special deposits) at the Bank of England. Following the introduction of new arrangements for monetary control on 20 August 1981, bankers' non-operational cash ratio deposits were excluded(3) from the monetary base.(4) Although the definition of M0 has not changed subsequently, banks' till money has been included, without being identified separately, in the published series for notes and coin in circulation since October 1986.

Bankers' operational balances have constituted a tiny component of M0. In January 1981 notes and coin in circulation outside the Bank of England accounted for almost 96% of M0, so bankers' operational balances amounted to just over 4%. Since then, the notes and coin series has grown at an average annual rate of nearly 6%, whereas bankers' operational deposits outstanding have fluctuated within a relatively narrow range (Chart 1). In August 2005, notes and coin in circulation accounted for 98.7% of the amount of M0 outstanding.

Chart 1
Notes and coin and bankers' operational deposits outstanding (not seasonally adjusted)



The implications of money market reform

Under the new money market arrangements to be introduced in 2006,(5) bank and building society

(1) The quantities are observed weekly on each Wednesday, and the monthly data are the average of the four or five weekly observations.
(2) For details of the construction of the monetary base, see Bank of England (1981).
(3) Special deposits would have continued to be excluded, had any been called.
(4) The monetary base was first referred to as M0 on page 14 of the *Financial Statement and Budget Report 1982–83*, 9 March 1982, whereas the statistical annex to the *Bank of England Quarterly Bulletin* introduced the term M0 in December 1983.
(5) See Bank of England (2005) and Clews (2005).

groups[1] will be able to hold reserve accounts at the Bank of England. For each reserve maintenance period they will choose a target for their reserve balances, up to a maximum of £1 billion.[2] If actual balances are within +/-1% of target on average over the maintenance period they will be remunerated at the Bank's current repo rate. Penalties will apply outside that range.

The total amount held in reserve accounts at the Bank will depend on the number of banks that choose to be part of the scheme and the level of reserves that they choose to maintain. As noted above, bankers' operational balances have been negligible as a proportion of M0 in the past. By contrast, under the new arrangements, bankers' reserves could form a large proportion — a third or more — of a combined aggregate.

The economic inferences which may be drawn from information on the growth of notes and coin in circulation and from information on the growth of banks' reserves will be very different. Notes and coin are overwhelmingly held in the household sector. They bear no interest, so we should expect households to hold them for transactions purposes, not as savings. Their rate of growth may therefore give some guidance as to the growth of households' current expenditure,[3] in particular retail sales. Banks' reserves, by contrast, will be influenced by several factors:

- The growth of banks' eligible liabilities. This aggregate should behave similarly to broad money (M4), and so should be correlated with the overall growth of nominal spending in the economy. But it may fluctuate according to the attractiveness to the non-bank private sector of holding certain types of bank deposit as against other possible forms of saving, and according to the banks' needs to attract deposits to finance their lending.

- Banks' decisions to increase or reduce their target reserves, subject to the maximum allowed by the Bank of England. These will reflect in part the interest rate return and other advantages offered by reserves relative to assets offering comparable liquidity, and in part banks' overall demand for liquid assets.

- A variety of possible events which could influence the relationship between reserves held by the banking system and eligible liabilities, but which may have no obvious economic implications. For example: decisions by banks to join or leave the voluntary reserve scheme; mergers or acquisitions between banks; decisions by the Bank of England to vary the maximum amount, or the maximum proportion, of eligible liabilities that banks are allowed to hold as reserves; the periodic recalculation of each bank's reserve ceiling;[4] and short-term fluctuations in the reserves available to the banking system as a result of changes in the Bank of England's own balance sheet.

The levels of notes and coin in circulation and of banks' reserves will also have entirely different implications for the seigniorage income accruing to the government and the Bank of England. Seigniorage income is the interest earned on the assets that correspond to the level of non interest bearing liabilities of the government and the Bank. The box on pages 370–71 explains these implications for seigniorage in more detail.

Publication plans

Since it is the Bank's view that the economic inferences to be drawn from the growth in notes and coin in circulation and from that in banks' reserves will differ significantly, the Bank proposes to cease publication of the aggregate series for M0 when the planned reforms to the money market have been implemented, currently scheduled between March and June 2006. But the Bank will still publish series for notes and coin in circulation as well as for banks' reserves held at the Bank of England.[5]

The series for notes and coin will be a continuation of the data that are currently published on a monthly basis, both in unadjusted and in seasonally adjusted terms, in Bank of England: *Monetary and Financial Statistics*. Series

(1) In the remainder of this article, the term 'banks' refers to both bank and building society groups. Within any group, only one entity may become a reserve scheme member.
(2) Or 2% of their sterling eligible liabilities, whichever is the higher. Sterling eligible liabilities broadly comprise sterling deposits (excluding deposits with other banks and building societies) and are intended to measure the size of a bank's sterling balance sheet after netting out interbank deposits. A fuller definition is provided in the Bank's monthly publication *Monetary and Financial Statistics*, available at www.bankofengland.co.uk/statistics/ms/current/index.htm.
(3) See Grant *et al* (2004) and Hauser and Brigden (2002).
(4) See Bank of England (2005), paragraph 38.
(5) It is possible that some banks will still hold non-reserve accounts with the Bank after the reforms.

for amounts outstanding, changes in these amounts, and various growth rates will continue to be published.(1)

The series for banks' reserves will replace the current data for bankers' operational deposits, leading to a discontinuity in the latter series (the back-run of data will continue to be available). Bankers' operational deposits have not been materially affected by seasonal factors, so the Bank has published only unadjusted data for this series. Likewise, the Bank will initially publish only unadjusted data on banks' reserves, in terms of amounts outstanding, changes in reserves, and growth rates. But over time, the Bank will analyse banks' reserves for seasonality and, depending on the outcome of that analysis, will decide whether or not to publish seasonally adjusted data as well.

Readers and users of the statistics with views on these proposals are invited to write, by the end of November 2005, to:

The Head of Monetary and Financial Statistics Division
Bank of England
Threadneedle Street
LONDON
EC2R 8AH

(1) Long runs of all series can be downloaded from the Statistical Interactive Database, available at www.bankofengland.co.uk/mfsd/iadb.

The origins of the monetary base (M0) and its role in seigniorage

The origins of the monetary base

In the second half of the 1970s, UK counterinflationary policy came to place greater weight on measures of aggregate money than before, evidenced by the publication of annual intermediate targets for broad money growth. The Conservative government elected in 1979 initially maintained targets for broad money growth, but, influenced by academic economists, it also considered monetary base control as an alternative technique to achieve its medium-term objective to reduce inflation.(1)

The theory behind monetary base control ran as follows. Given the definition of the monetary base *(B)* we can write:

$$B \equiv C + R \qquad \textbf{(1)}$$

where C is notes and coin in circulation with the public (ie the non-bank private sector) and R denotes banks' reserves (the total of banks' till money and bankers' operational deposits at the Bank of England). The broad money stock *(M)* comprises sterling bank deposits held by the non-bank private sector *(D)* as well as its holdings of notes and coin:

$$M \equiv C + D \qquad \textbf{(2)}$$

Both **(1)** and **(2)** are identities rather than behavioural expressions. So, dividing **(2)** by **(1)**, the broad money multiplier can be expressed as:

$$\frac{M}{B} \equiv \frac{C+D}{C+R} = \frac{c+1}{c+r} \qquad \textbf{(3)}$$

where c represents the ratio of notes and coin in circulation with the public to bank deposits and r is the ratio of banks' reserves to their deposit liabilities.

Banks needed to hold these high-powered cash reserves to maintain the convertibility of their deposit liabilities into legal tender (currency). So theoretically, the monetary authorities could use open market operations to control the monetary base, and provided both c and r were stable and predictable, the authorities could then also determine the broad money stock.

The public's cash/deposit ratio, c, was thought likely to be predictable but to be affected by the opportunity cost of holding cash rather than interest-bearing bank deposits, as well as by technological developments in the payments system, such as the spread of automated teller machines. Historically, the banks' reserve ratio, r, had been steady, reflecting the UK policy of supplying additional reserves to the banking system on demand at an interest rate chosen by the authorities. However, monetary base control would imply that banks would be refused access at any price to reserves beyond those that the Bank of England planned to supply. That could lead to greater volatility in banks' desired reserve ratios and much greater volatility in short-term interest rates, which would then be determined by the market rather than monetary policy makers. Monetary base control was therefore rejected as policymakers were uncertain as to the amount of reserves that banks would wish to hold under such a system.

In fact, the multiplier linking the broad money stock (M4) to M0 has proved to be anything but stable. This reflected large movements in both c and r: c fell from 0.09 at the start of the 1980s to 0.03 in the early 1990s, whereas r fell from 0.02 to 0.01 over the same period. Both have remained around those levels since. Consequently, M4 has tended to rise at a much faster rate than M0, especially in the 1980s.

M0 as the basis for seigniorage

The narrow money aggregate (M0) comprises liabilities of the government (coins) and the Bank of England (banknotes and bankers' operational deposits). The following simplified consolidated budget identity for the government sector(2) illustrates that the government can finance its net expenditure either by issuing government debt *(N)*(3)

(1) One of the first academic proponents of monetary base control was Meltzer (1969). For a fuller exposition of the arguments for and against monetary base control in the United Kingdom, see Foot *et al* (1979), HM Treasury and Bank of England (1980), Fforde (1983) and Goodhart (1989).
(2) In this simplified description, the government sector is taken to include both the government and the Bank of England.
(3) In practice, government debt is a net concept, reflecting government debt net of government assets.

or through monetary financing (increasing the stock of M0, ie the total change in C and R below):

$$\Delta C + \Delta R + \Delta N \equiv G - T + iN \quad \textbf{(4)}$$

where Δ indicates the change in a variable, G is government spending, T denotes net taxes and i is the average nominal interest rate paid on government debt. Since no interest is paid to holders of notes and coin, nor, in general, on bankers' operational deposits, the total amount of M0 in its current definition is a non interest bearing liability either of the government or the central bank. But the government and the central bank earn interest on the assets that correspond to these liabilities, such that M0 forms the basis for seigniorage revenue accruing to the government sector.(4) Following the impending money market reforms, banks' reserves (excluding banks' till money) will become interest bearing and thereby, in this simplified framework, comparable to government debt. Equation **(4)** can then be restated as:

$$\Delta C + \Delta R + \Delta N \equiv G - T + i(R + N) \quad \textbf{(5)}$$

Seigniorage will then only be earned on the amount of notes and coin in circulation outside the Bank of England, thus providing an additional reason to cease the calculation and publication of the stock of M0 and instead to publish data on notes and coin in circulation separately from banks' and building societies' reserves.

(4) In practice, seigniorage on notes and coin accrues to the government, while that on bankers' operational balances accrues in the first instance to the Bank of England. Seigniorage accruing to the Bank of England may be paid to the government as profit or in taxation, or may be retained by the Bank, to meet costs or as capital.

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The determinants of household debt and balance sheets in the United Kingdom

Working Paper no. 266

Merxe Tudela and Garry Young

The outstanding debt of the UK household sector moved above £1,000 billion in 2004, equivalent to around 140% of household income (compared with around 105% ten years earlier). The rapid accumulation of debt has raised questions about the ability of people to repay what they owe, especially in the event of a sudden change in economic circumstances. This could have implications for both monetary policy, if the combination of high debt levels and a worsening economic outlook were to cause a slowdown in spending by households, and financial stability, if an increasing number of households were to default on their debts. It is therefore important to understand what lies behind the increase in debt and to assess its future sustainability.

Debt sustainability cannot satisfactorily be addressed by looking at the aggregate balance sheet of the household sector alone. There are substantial differences across households and shocks to the household sector are likely to affect different households in different ways. This paper proposes a framework for understanding aggregate indebtedness in terms of individual optimising decisions and adopts a model to explain the rise in borrowing. The model is set up to be consistent with the aggregate, cross-sectional and cohort experience of British households using information from the British Household Panel Survey. This process of calibrating the model reveals some inconsistencies between the basic life-cycle model of household behaviour used here and what is observed in practice. In particular, the level of debt is lower than expected at both extremes of the age spectrum. We therefore modify the basic model so that it can account for the observed cross-sectional balance sheet position of British households.

The model may be used to look at how balance sheets might develop in the future, on the assumption that it adequately captures current and future household behaviour and dependent on future trends in its determining factors such as real interest rates, house prices and incomes. This can be used as means of assessing the 'sustainability' of recent high debt levels. Sustainability of debt can be judged in two ways: whether debt will remain at or above current levels; and whether it is affordable. On the first test, this depends critically on the expected path for key determining variables. The paper shows that different future paths for the real interest rates could lead to a higher or lower debt-income ratio, suggesting that sustainability can only be assessed conditional on a view of how these determining factors are likely to develop. In neither case, however, do recent debt levels look unaffordable to the typical individual. Even if real interest rates were to revert to the higher levels seen in the late 1990s, the future consumption of even the most indebted cohorts would exceed that enjoyed by older cohorts today, reflecting the impact of past and future economic growth. Of course, the emergence of unexpected shocks would have an adverse impact on households. We have illustrated the effect of higher interest rates, lower house prices and lower pension incomes. All would cause a contraction in household spending and change the equilibrium debt-income ratio. The more severe the shock the more likely that the sustainability of debt would become an issue. While we are unable to assess the likelihood of such shocks with the current model, it is nevertheless a useful tool for assessing the severity of their impact.

Bank loans versus bond finance: implications for sovereign debtors

Working Paper no. 267

Misa Tanaka

Since the 1990s, syndicated bank lending to emerging market sovereigns has declined steadily, while eurobond issuance has increased. This paper tries to explain why these countries have recently shifted towards bond finance and considers the implications.

In this model, sovereigns' incentive to repay their debt arises from their desire to avoid a financial crisis which could be triggered by a default. Sovereigns have different risk characteristics, and the information about their creditworthiness can only be obtained through costly monitoring. Whereas banks can monitor their borrowers directly, the cost of monitoring is too high for small individual bondholders. But sovereigns wishing to issue bonds can hire a credit rating agency to monitor them and publish its assessment. Therefore, the critical difference between bank lending and bond finance is that banks act as private monitors and keep their assessment of the borrower private, whereas rating agencies act as public monitors and disseminate this information not only to the existing bondholders but also to third parties — ie potential future creditors. Consequently, bank loans are non-transferable whereas public monitoring makes bonds transferable by eliminating the information asymmetry between the existing creditors and potential future creditors.

When the timing of cash flow is uncertain, borrowers prefer long-term financing because short-term credit entails a risk of interim debt restructuring and crisis. Transferability makes bonds cheaper for long-term financing compared to bank loans, given that it is costly for banks to commit to holding a claim for multiple periods. Thus, when the cost of information dissemination is low and crisis costs are large, borrowers issue long-term bonds for financing projects with uncertain timing of cash flows, and use bank loans only for financing strictly short-term projects.

Our analysis shows that there are two inefficiencies in the current international financial system which is dominated by long-term bond financing. First, although the possibility of a financial crisis is necessary to prevent strategic defaults, it is *ex post* a deadweight cost if a default is unavoidable. Second, long-term bond issuers are subject to moral hazard, because the fear of a financial crisis prevents them from restructuring their unsustainable debt at an early stage. We demonstrate that state-contingent debt and IMF intervention to prevent a crisis conditional on the restructuring of an unsustainable debt are both welfare improving.

Forecasting using Bayesian and information theoretic model averaging: an application to UK inflation

Working Paper no. 268

George Kapetanios, Vincent Labhard and Simon Price

Recently, there has been increasing interest in forecasting methods that utilise large data sets. There is a huge quantity of information available in the economic arena which might be useful for forecasting, but standard econometric techniques are not well suited to extract this. In an effort to assist in this task, econometricians began assembling large macroeconomic data sets and devising ways of forecasting with them. Standard regression techniques cannot be used in this context, as the number of variables is far too large. Instead, broadly speaking there are two methodologies that can be applied: factor modelling and forecast combination. In the former, a factor structure is imposed on the data and then techniques such as principal components are used to extract the factors that are subsequently used in forecasts. This approach has been widely used in macroeconomic forecasting in recent years.

The alternative methodology is forecast combining, often of simple and probably misspecified models. This grew out of the observation by forecast practitioners in the 1960s that combining forecasts (initially by simple averaging) produced a forecast superior to any single forecast. If it were possible to identify the correctly specified model and the data generating process (DGP) is unchanging, then this approach would not be sensible. However, models may be incomplete, in different ways; they employ different information sets. Forecasts might be biased, and biases can offset each other. Even if forecasts are unbiased, there will be covariances between forecasts which should be taken into account. Thus combining misspecified models may, and often will, improve the forecast.

Despite this, combining forecasts will not in general deliver the optimal forecast, while combining information will. Nevertheless, it may not be practicable to estimate the fully encompassing model, not least because the set of variables is vast. Thus we have a justification for combining forecasts. One could call this the frequentist misspecification case. It should be clear that in this context forecast combining is viewed as mainly a stop-gap measure that works in practice but would be surpassed by an appropriate model that addressed the underlying misspecification. A further practical problem is that with standard combining methods the forecast weights can only be reliably constructed for a relatively small number of models. Nevertheless, given that the true DGP may involve a vast number of variables, it is clear that forecast combination is a route into the combining of information, and this is how it is interpreted in the literature relating to large data sets.

Forecast combining can be also be interpreted in a Bayesian framework. Here it is assumed that there is a distribution of models. The basic problem, that a chosen model is not necessarily the correct one, can then be addressed in a variety of ways, one of which is Bayesian model averaging. A chosen model is simply the one with the best posterior odds, but posterior odds can be formed for all models under consideration and offer weights for forecast combinations.

There is an analagous frequentist information theoretic approach, on which we focus in this paper. Given we have a set of models, we can define relative model likelihood. Model weights within this framework have been suggested by Akaike in a series of papers. In practical terms such weights are easy to construct using standard information criteria. Our purpose, then, is to consider this way of model averaging as an alternative to Bayesian model averaging.

We address this in two ways. We first assess the performance of information theoretic and other model averaging techniques by means of a Monte Carlo study. We then examine how various schemes can perform in forecasting UK inflation. For this, we use a UK data set which emulates a well-known data set constructed by Stock and Watson for the United States. We find that model averaging techniques can be beneficial with the information theoretic weights performing very well. Our findings partly confirm that Bayesian model averaging can provide good inflation forecasts, but we find that the frequentist approach also works well, and dominates in a large subset of the cases we examine for UK data. It is unlikely that a single technique would be more useful than all others in all settings. Nevertheless, our work indicates that information theoretic model averaging provides a useful addition to the forecasting toolbox of macroeconomists. Indeed, we find that the information theoretic method is the most robust of those we examine.

This paper does not describe the way in which the Bank of England generates its forecasts. The findings in this paper pertain to a specific type of forecasting model which is only part of a much broader approach to forecasting applied at the Bank. The Bank does not use a single model to forecast inflation or other variables; instead it uses a 'suite' of many models ranging from purely theoretical through purely data driven to the Bank's macroeconometric model, the Bank of England Quarterly Model (BEQM). All these models are useful in a particular context: in no case will any one model provide a uniquely best forecast.

Accounting for the source of exchange rate movements: new evidence

Working Paper no. 269

Katie Farrant and Gert Peersman

Considerable research has previously been carried out to try to explain past movements in exchange rates. We examine this issue by estimating a structural vector autoregression, with sign restrictions, for the United Kingdom, the euro area, Japan and Canada versus the United States. The structural vector autoregression identifies not only demand, supply and monetary policy shocks, which may be important in explaining exchange rate movements, but also specific exchange rate shocks. These exchange rate shocks can be thought of primarily as movements in the exchange rate which are not explained by fundamentals. As far as we are aware, this is the first time that specific exchange rate shocks have been identified using sign restrictions, which is a much more general and less stringent approach than traditional identifying procedures.

We find that, while fundamentals have been important in explaining movements in exchange rates, there are also specific exchange rate shocks that have had a significant influence in determining exchange rate paths over time. This is in contrast to a number of other studies, which suggest that exchange rate movements can primarily be explained by demand shocks. Applying the traditional identifying strategy based on long-run restrictions to our data set, however, supports the findings of these other studies, suggesting that the identification strategy is important in determining the results.

A model of bank capital, lending and the macroeconomy: Basel I versus Basel II

Working Paper no. 270

Lea Zicchino

The process of reforming the 1988 Basel Accord, that started in 1999, has been motivated by the goal of more closely matching regulatory capital to the risk profile of banks' asset portfolios. The rationale for minimum capital requirements is that they mitigate financial institutions' moral hazard. Regulators are imposing a cost on bank owners to 'encourage' them to avoid costly default. However, the limited number of risk categories in the current framework has created opportunities for banks to increase the risk to which they are exposed without increasing the amount of regulatory capital.

The new Basel Accord is widely recognised as a much needed effort to deal with the shortcomings of the current system. By realigning capital adequacy rules with banks' incentives it aims at restoring the link between risk and capital holding. Nonetheless, a number of questions have been raised by central bankers, regulators and practitioners regarding the impact of a more risk-sensitive regulatory framework on macroeconomic stability. Among them, there is the issue of the potential procyclical effects of the new capital adequacy requirements, ie the possibility that during periods of weak economic growth, a fall in capital ratios and an increase in regulatory requirements implied by a deterioration in the risk profile of banks' assets might increase the likelihood of credit contraction and, therefore, a further weakening of growth.

This paper analyses the relationship between banks' capital holdings, banks' loans and macroeconomic activity under risk-sensitive capital adequacy requirements. In particular, it compares the impact of macroeconomic shocks on banks' choices of capital structure and loan supply under the old and new capital adequacy regimes. It does so by extending a model that investigates the impact of monetary policy on lending in an economy where banks operate in an oligopolistic market and are subject to minimum capital requirements. In order to analyse banks' reaction to changes in macroeconomic conditions under the new capital adequacy regime, I extend the model by assuming a link between loan risk-weights and borrowers' creditworthiness. In particular, I introduce asset risk-weights that vary with macroeconomic performance, which is a major determinant of credit risk.

The first result of the paper is that the response of banks to shocks that affect loan demand differs when the minimum capital requirements are calculated with asset risk-weights that are sensitive to macroeconomic conditions. In particular, bank capital is less volatile than under capital requirements with constant risk-weights. The intuition behind this result can be understood by considering, for example, a positive shock to macroeconomic conditions that increases both current and future loan demand. If the capital constraint is binding, banks may not be able to expand loan supply in the current period and they may need to raise capital to increase supply in the future. Therefore, if capital requirements do not change with borrowers' risk, capital increases in response to positive macroeconomic shocks and decreases after negative shocks. But when asset risk-weights depend on macroeconomic conditions, bank capital might not need to increase for banks to be able to expand their credit supply. In fact, following a positive macroeconomic shock the risk-weights decrease and the capital constraint thus become looser. This insight has an important policy implication. On the one hand banks will tend to operate above the minimum regulatory capital to avoid the capital constraint becoming binding in future periods. On the other hand banks may not voluntarily accumulate capital in times of good macroeconomic conditions because it is during these times that the capital constraint becomes looser. This means that if banks are affected by an adverse shock during a period of credit expansion, they might be forced to raise capital at a time when market conditions are unfavourable. A second and related result of the paper concerns the effect of macroeconomic shocks on loan supply. Since capital is more difficult to accumulate in a recession, and easier to accumulate when the economy experiences a positive shock, bank credit is likely to be more procyclical under the new Accord than under the current one.

Consumption, house prices and expectations

Working Paper no. 271

Orazio Attanasio, Laura Blow, Robert Hamilton and Andrew Leicester

Over much of the past 25 years, the cycles of house price and consumption growth have been closely synchronised. Three main hypotheses for this co-movement have been proposed in the literature. First, that an increase in house prices raises households' wealth, which increases their desired level of expenditure. Second, that house price growth increases the collateral available to homeowners, reducing credit constraints and thereby facilitating higher consumption. And third, that house prices and consumption have tended to be influenced by common factors (eg productivity growth or tax changes), which cause revisions to households' expected lifetime income. This paper uses individual household level data to assess the importance of these different hypotheses. Revisiting this link seems particularly timely, as the housing market has cooled since the end of 2004, generating widespread press speculation about the outlook for prices. In addition, there is the puzzle, discussed in a box in the Bank of England's *Inflation Report* in November 2004, about the recent decline in the correlation between house price and consumption growth, and hence the likely impact of house prices on consumption in the future.

Many previous related studies have focused on the late 1980s consumption and house price booms. Attanasio and Weber recognised that microeconomic data on individual households' expenditure provides a way to distinguish between the competing wealth and common causality hypotheses. If wealth effects were important, older homeowners — who are less likely to demand more housing services in the future — should be the primary beneficiaries of a house price boom and should increase their consumption the most. In contrast, if house prices and consumption are both influenced by common expectations of income growth, younger consumers, with a greater remaining lifespan to realise the gain, should be the ones to raise consumption the most. Their paper argued that common causality was the more likely explanation for the late 1980s correlation. But since then, many other studies, mainly relying on aggregate data, have argued that there is a direct wealth effect.

This paper extends and updates Attanasio and Weber's results, covering data spanning the consumption and house price weakness of the early 1990s, and developments up to and including 2001. We estimate various specifications for individual households' consumption using pseudo-cohorts drawn from 24 years of the Family Expenditure Survey between 1978 and 2001/02. In our baseline specification, the consumption of a household in a given year depends on the cohort to which it belongs, the age of the head of household and various other demographic and household characteristics. We then assess the extent to which adding various house price terms to our baseline model can help explain the consumption patterns over time. By analysing the results for households in different age groups, we determine whether house price movements appear to be a more important determinant of the consumption of younger or older households, or of renters or homeowners, using similar identifying assumptions to those previously used by Attanasio and Weber.

We find several pieces of evidence which suggest that common causality has been the most significant explanation for the co-movements between house price and consumption growth. First, younger cohorts had the largest swings in expenditure during the consumption and housing cycles. Second, the effect of regional house price growth on consumption is found to be stronger for these younger households. Third, the coefficient on the regional level of house prices is as large for younger as for older households, while they had a greater response to the effect of 'unexpected' house price movements. And fourth, the consumption of both homeowners and renters are equally aligned with the house price cycle. Of course, it remains likely that the wealth and collateral channels are important for some households at some points in time. But the evidence in this paper suggests that the main reason for house prices and consumption being correlated in the past is changes in common driving factors — like income expectations.

What caused the early millennium slowdown? Evidence based on vector autoregressions

Working Paper no. 272

Gert Peersman

This paper analyses the underlying causes of the recent slowdown and preceding expansion for the industrialised world (proxied by an aggregate of 17 countries), the United States and the euro area. In order to do the analysis, vector autoregressions (VARs) are estimated for the sample period 1980 Q1–2002 Q2 containing output, inflation, interest rates and oil prices. The impact of aggregate supply, aggregate demand, monetary policy and oil price shocks is estimated.

A crucial problem when using VARs is the identification of the structural shocks. We compare the results of two identification strategies. The first one is based on conventional zero contemporaneous and long-run restrictions. Specifically, a number of restrictions are imposed on the immediate impact of a shock on certain variables (for instance, allowing no immediate effect of monetary policy on output) or on the long-run effects of specific shocks (for instance, ensuring the long-run neutrality of monetary policy). These restrictions are, however, very stringent in many cases. Short-run restrictions are typically not based on theoretical considerations, and long-run restrictions can be highly misleading. We therefore propose an identification strategy based on more recent sign restrictions as an alternative (for example, after a restrictive monetary policy shock, the sign of the output reaction is not positive). Hitherto, this type of restriction has only been used to identify monetary policy shocks. We extend this method to our larger set of structural shocks. The advantage of this procedure is that we do not have to impose strong and perhaps implausible constraints. By contrast, our alternative approach only makes explicit use of restrictions that researchers often use implicitly. Often, researchers experiment with the model specification until the results look reasonable; for example, a restrictive monetary policy shock is expected to have a negative impact on prices and a temporary effect on output. This *a priori* theorising is made more explicit with sign restrictions, and at the same time, no additional short and long-run conditions are necessary. As a result, this approach is much more general.

We show that the identification strategy is indeed important, in particular for oil prices and monetary policy shocks. The difference between both approaches is statistically and economically very important. After a restrictive monetary policy shock, the maximum impact on output is -0.3% with conventional restrictions, whilst the impact is estimated to be between -0.4% and -1.0% with sign constraints.

When applying both methods on recent output fluctuations, we find that the recent slowdown was caused by a combination of several shocks. Across both methodologies, we find an important role for negative aggregate spending shocks. In addition, there were negative aggregate supply shocks, negative effects of restrictive monetary policy in 2000 and a negative impact of oil price increases in 1999. The magnitude of the latter two is significantly different between both approaches. We find an important role for oil price shocks with conventional restrictions and for monetary policy shocks using sign conditions. The shocks are also more pronounced in the United States than in the euro area.

‘Real-world’ mortgages, consumption volatility and the low inflation environment

Working Paper no. 273

Sebastian Barnes and Gregory Thwaites

This paper considers the interaction between the microeconomic decisions facing households and the macroeconomic environment in a setting where households have ‘real-world’ mortgage contracts. In particular, we consider the possible consequences of the important changes in the framework for setting monetary policy in the United Kingdom in recent decades.

The change in monetary policy regime from the 1980s to the 1990s has been associated with greater stability of the macroeconomic environment. ‘Real-world’ mortgages may provide an explanation of how more stable economic conditions have contributed to reducing the volatility of aggregate consumption through effects not captured in elementary textbook models of consumption with debt. In these models, it is typically assumed that household borrowing takes the form of successive one-period debt contracts, denominated in units of consumption. Actual mortgage contracts — the biggest financial commitments that most households ever make — look very different to this: they are denominated in nominal terms with repayments over many periods, sometimes with fixed nominal interest rates. This paper is concerned with the role of such real-world mortgage contracts in consumption volatility.

We use a model of real-world mortgages to show the effects at household level of the change in monetary policy regime under adjustable-rate and fixed-rate mortgages. We use this to model aggregate consumption uncertainty in a partial equilibrium overlapping generations framework.

At household level, we find that non-housing consumption would be smoother over the life cycle in the more stable 1990s regime. The change of regime generates substantial welfare gains for mortgage holders. Even though households now have more mortgage debt than in the past, we find that households could still enjoy similar levels of utility from non-housing consumption in the 1990s as in the 1980s regime. This suggests that households may have increased their demand for housing in response to the lower cost and greater certainty of mortgage borrowing in the 1990s.

The main parameterisation of the model suggests, counterintuitively, that aggregate consumption volatility under the 1990s regime would actually be higher in the steady state than in the 1980s regime, other things being equal. Although macroeconomic shocks have become less pronounced, this result suggests that households’ responses to shocks have become more synchronised.

Furthermore, higher indebtedness in the 1990s has also tended to make aggregate consumption less stable. This result shows how the more stable economic environment associated with the 1990s regime would not necessarily translate into greater stability of aggregate consumption given real-world mortgages. If the assumptions necessary for this result hold, the observed fall in aggregate consumption volatility in the 1990s would either have to be explained by other offsetting factors or because the economy was in a period of transition between two regimes rather than the new steady state; households in the 1990s actually benefited simultaneously from the more stable macroeconomic environment, and the lower levels of indebtedness inherited from the past.

The substitution of bank for non-bank corporate finance: evidence for the United Kingdom

Working Paper no. 274

Ursel Baumann, Glenn Hoggarth and Darren Pain

The aim of this paper is to investigate empirically the links between alternative forms of corporate debt finance using data on the UK economy. Based on a small panel data set of UK-owned banks for the 1986 Q3–2001 Q3 period, we estimate equations for the quantity of bank credit to the corporate sector. In particular, we investigate the extent to which changes in non-bank finance — either from (bond and other debt securities) markets or from non-bank financial institutions — affect the growth in corporate loans of UK-owned banks. In doing so, we aim to investigate the degree of substitutability or complementarity between bank and non-bank finance. Moreover, we examine whether these relationships are different in periods when non-bank finance falls sharply to assess whether bank credit acts as a back-up source of funding when other forms of finance are not readily available.

In order to understand the potential interaction between bank and non-bank markets, an important distinction relates to the separate influences of supply and demand factors. But there is an identification issue: observed changes in corporate bank and non-bank finance will reflect movements in both the supply of and demand for external funds and it is difficult to disentangle the two. To address this issue, we exploit information on the average interest rates banks charge on their corporate loan portfolios. By considering how these loan rates respond to developments in non-bank finance markets in conjunction with the changes in the amount of credit extended, we hope to throw light on whether supply or demand influences are more important, particularly during periods of stress in non-bank finance.

Our results suggest that there is substitutability for companies between bond finance and bank loans from the large UK-owned banks. In particular, the growth in bank lending of the major UK-owned banks increases around some periods of bond market stress as well as during more tranquil periods when bond spreads widen. In general, the loan rates of the large UK banks are not found to be sensitive to changes in non-bank finance. This could reflect a relatively flat loan supply curve whereby banks increase the amount of credit extended when, for example, bond spreads rise substantially without increasing their loan rates. This would be consistent with firms using their arranged loan facilities with banks to absorb shocks in the availability of other forms of external finance. In this way, banks may passively accommodate shifts in the demand for bank loans that are associated with disturbances in non-bank finance.

However, there are some variations in the results for different forms of non-bank finance. This suggests that banks' responses may depend on the nature of the shock. In periods when bond spreads widen sharply, bank loans would seem to provide alternative finance for corporates, at largely unchanged interest rates. This would be indicative of companies switching their demand for external finance away from capital market financing to bank loans, and is consistent with the notion of substitutability between alternative forms of finance. However, disruptions to the amount of corporate bond and commercial paper issuance seem to be associated with an increase in loan rates and either a fall or unchanged bank lending growth. This appears to be consistent with higher corporate demand for bank finance being choked off by a decline in loan supply by banks.

The Governor's speech at Salts Mill, Bradford[1]

While I was growing up in the West Riding, Salts Mill was still thriving, although the year I left Yorkshire was the year in which the Salts Group was taken over. As the textile industry declined, so did the fortunes of Salts Mill and closure became inevitable. Since then the wheel of fortune has turned full circle. The remarkable vision and energy of Jonathan Silver and his family have converted the mill from a daily reminder of the decline of the Bradford textile industry into an extraordinary example of urban regeneration. Tonight I want to talk about the results of another spin of the wheel of fortune. In its time, Titus Salt's mill was the response to globalisation in the nineteenth century. Salt decided to specialise in importing alpaca wool from Peru and turning it into the finest fabrics in the country for sale at home and abroad. Today, almost every company in Britain is affected by globalisation. And the experience of every successful economy since the end of the second World War shows that our ability to embrace globalisation is the key to higher living standards.

Three aspects of this increasing integration of economies are particularly important for the Bank of England when it sets monetary policy: the impact of new sources of production overseas on prices in the high street; the influence of falls in import prices on the growth of consumer spending; and the role of migrant labour in easing wage pressure in a tight labour market. Let me take these in turn.

First, despite rapid growth of domestic demand over a number of years, inflation has remained low. Over the past year consumer prices as a whole have risen by a fraction less than the target for inflation of 2%, and the prices of goods hardly at all. Until recently, import prices have played a part in keeping inflation low. Falling import prices affected inflation directly, by lowering the prices of the imported goods that we consume, and indirectly, by increasing competitive pressure on domestically produced goods, and by lowering the cost of imported inputs such as raw materials and machines. So why have our imports become cheaper?

Some of the countries from which we import have experienced extraordinary rates of productivity growth. That has allowed them to reduce production costs and the prices at which they sell to us. Such a surge in productivity growth is not unprecedented. Between 1800 and 1850 there was a staggering increase in the productivity of textile manufacturing in Britain. All the processes involved in transforming raw wool into finished cloth — combing, spinning and weaving — were, one by one, mechanised. That led to a huge increase in the output of textiles and a large fall in their price, thus stimulating demand further. Between 1800 and 1850 the output of the UK textile industry increased seven-fold, and the price of textiles relative to other goods fell by three quarters. Over time productivity in other countries caught up, as technology and capital were exported from the United Kingdom. As other countries became more efficient at producing textiles, the industry in the United Kingdom went into decline. At its peak in 1821, the UK textile industry accounted for 14% of national income. In 2004, it represented only 1%. That decline meant a painful process of adjustment for those in the industry — not least in and around Bradford — but new jobs were created in other industries. Salts Mill in Bradford and Dean Clough in Halifax are examples of successful regeneration. Unemployment in Bradford, as in the country as a whole, is close to its lowest level for a generation. And our living standards are undoubtedly higher today than if we had attempted to retain the industrial structure of the nineteenth or early twentieth centuries.

East Asia is now the dominant producer of textiles. China has doubled its share of world textile exports over the past 15 years, and now accounts for one fifth of world textile trade. And that share is likely to increase further following the lifting of trade restrictions on textile imports from China at the beginning of this year, which led to an immediate jump in imports into the United States and Europe. China is now importing the technology and capital that will raise productivity towards levels of more traditional industrialised nations. The new technology adopted at Salts Mill and elsewhere

(1) Delivered on 13 June 2005 at Salts Mill, Bradford, Yorkshire. This speech can be found on the Bank's website at www.bankofengland.co.uk/publications/speeches/2005/speech248.pdf.

led to cheaper textiles around the world; now the advent of China and India to the world trading system is reducing prices of imported textiles and other goods. As a result, the prices of imported goods have been falling, contributing to low inflation in Britain.

The second implication of economic integration, and one that follows directly from the first, is that falling import prices helped to boost real disposable incomes and hence consumer spending. Industrialisation in China and elsewhere has benefited British consumers. For much of the past decade, the terms on which we were able to trade with the rest of the world moved in our favour. In other words, the average price of our exports rose relative to the price of our imports. And that enabled consumer spending to rise faster than national output. From 1997 until around 2002 consumer spending rose at an average rate of almost 4% a year, whereas GDP rose at an average annual rate of less than 3%. But over the past two to three years the improvement in our terms of trade has been less marked. At the same time real income growth slowed. The result, inevitably, was that consumption spending also moderated. And since the turn of the year a more pronounced slowing has become evident.

The third effect of increased economic integration is its impact on the labour market. An economy which is open to migrant labour exhibits a different inflationary process from one that is not. Changes in interest rates affect inflation in part through their effect on the balance between total demand and the supply capacity of the economy — a balance described by some economists as the output gap. An increase in spending raises the pressure of demand on supply and leads to upward pressure on wages and prices. But if the increased demand for labour generates its own supply in the form of migrant labour then the link between demand and prices is broken, or at least altered. Indeed, in an economy that can call on unlimited supplies of migrant labour the concept of the output gap is meaningless.

The United Kingdom is not in that extreme position, but the inflow of migrant labour, especially in the past year or so from Eastern Europe, has probably led to a diminution of inflationary pressure in the labour market relative to previous experience. Comprehensive and accurate statistics on all migrant workers are not available, but we do have some information that illustrates the increasing importance of inflows of migrant labour. The Home Office estimates that around 120,000 workers entered the United Kingdom from the new member countries of the European Union between May 2004 and March 2005. That is not far short of the average annual increase in the labour force over the past decade. Without this influx to fill the skill gaps in a tight labour market it is likely that earnings would have risen at a faster rate, putting upward pressure on the costs of employers and, ultimately, inflation.

The impact of globalisation in those three areas — on prices in the high street, on real incomes and consumer spending, and on wage costs — is central to monetary policy today. And some of that impact is starting to unwind. What does this mean for the future path of interest rates? The starting point is that inflation is very close to target and the economy is still growing at a rate not far from its long-run average. But final domestic demand growth has weakened for five consecutive quarters. Some easing was desirable in order to bring about a rebalancing of the economy after a prolonged period during which domestic demand had grown much faster than output, and should help to reduce our trade deficit which is now between 3% and 4% of national income. But inevitably it increases the uncertainty about whether the pattern of growth in the future will be as smooth as we have experienced over the past decade.

Those concerns have been fuelled by the sharp slowing of consumer spending in recent months. The weakness in sales of goods on the high street — from clothes to cars — has been marked. Nevertheless, consumption of services appears, at least so far, to be more resilient. So it is possible that we are seeing a temporary slowdown in spending on durable and semi-durable goods — such as household goods, cars and clothes — as households come to terms with the prospect of somewhat lower income growth in future.

The risks around that view are the key to policy. One downside risk to activity and inflation is the immediate outlook for consumer spending. If the weakness in spending on goods were to spread to services then the slowdown in consumption growth might be more protracted. Given the historically low level of national savings in the United Kingdom, and the increasing awareness of the need to provide for the future, it is possible that an increase in savings has already begun. While that would be a positive development for the United Kingdom in the long term, it would imply slower growth of domestic demand in the short run.

But there are also upside risks to inflation. First, broad money has been rising rapidly in the United Kingdom, and in recent months its growth rate has risen further. In the first quarter of this year it rose at an annualised rate of nearly 13%, more than twice as fast as in the United States and euro area. And in real terms it is rising more rapidly than at any point since 1997. That represents an upside risk to domestic demand.

Second, the downward pressure on inflation from falls in import prices may have come to an end. Import prices, which had been falling for several years, started to rise in the second half of 2004 as the world economy grew strongly. And in the first quarter of this year imported goods prices were 3.7% higher than a year ago. There is a risk that import prices will continue to put upward pressure on inflation.

Third, the risks to labour costs seem to be on the upside. Private sector regular pay growth has been subdued, which is somewhat puzzling in the context of 30 year-high employment rates, and 30 year-low unemployment rates, which we would usually associate with a tight labour market. It is possible, indeed likely, that inflows of migrant labour have eased labour market pressure. But there is a risk that the effect of migrant labour on wage costs may diminish if the inflows over the past year represented a one-off adjustment to the new opportunities to work in Britain. And to the extent that those inflows helped to reduce upward pressure on wage costs in a tight labour market, then equally the reversal of the flows of migrant labour might reduce the downward impact of a softer labour market on wage costs.

Judging the balance of those risks is a difficult task, but what matters most is that the Monetary Policy Committee will react promptly to whichever of these risks appears to be materialising in the months ahead. As a true Yorkshire batsman would say: be ready to play on either foot, and keep your eye on the data.

If Titus Salt could join us today he would recognise not only his former mill, but also the way in which globalisation affects prices, productivity and industrial structure. He would appreciate too the importance of long-run monetary stability that the inflation target aims to achieve and that enables you to focus on your businesses, which are the true source of rising living standards.

The Governor's speech[1] at the Mansion House

My Lord Mayor, Mr Chancellor, Mr Vice-President, Your Excellency, My Lords, Aldermen, Mr Recorder, Sheriffs, Ladies and Gentlemen:

Tonight's dinner is in honour of the merchants and bankers of the City of London. The merchants have not always seen eye to eye with the bankers. Exactly 300 years ago, an anonymous merchant published a pamphlet attacking the Bank of England's power to set interest rates and bemoaning its consequences for the constitution of this country: 'the Bank … is in the hands of [those] who are not liable to any Personal Penalty. The Government will be … in the Hands of the Bank, and may be undone either at long run by being supply'd at too dear a Rate, or at once by not being supply'd at all.' These days, merchants are more concerned about the effect of interest rates on their businesses than on the Government. And the Government has asked the Bank to set interest rates to maintain stability by meeting the inflation target. So relations between merchants and bankers are now more cordial. Lord Mayor, thank you for again bringing us together.

Since we last met in this magnificent room, the General Election returned the Government to office for a record-breaking third time. And since 1997 there have been nine Lord Mayors, eight French finance ministers, seven shadow Chancellors, six Italian finance ministers, five Secretaries of State for Trade and Industry, four US Treasury Secretaries, three permanent secretaries in HMT, two Governors, and, yes, just one Chancellor. Chancellor, we congratulate you on your longevity in office.

You have certainly changed the Treasury. But I rather regret that you have not suggested moving the Mansion House Dinner back to its more traditional date in October, where it was from 1931 to modern times, suitably halfway through the financial year and midway between Budgets. When the Budget was moved — temporarily — to November in 1993, the dinner was switched to June. But for some reason it did not move back to its Autumn date when the Budget reverted to the Spring.

The idea of a June or July date had been mooted on several earlier occasions, but had not found favour. In early 1949 a senior Treasury mandarin wrote to the Deputy Governor:

'The annual bean-feast for the Merchants and Bankers won't be able to take place in October' [this showed foresight since sterling was devalued in September of that year]. 'They are thinking of July as an alternative…. But I don't like it very much…. In July, Parliament is just about to rise at the end of a long and exhausting session; everybody… is panting to get away on holiday; and the financial year is only about a quarter of the way through. In October, by contrast, our holidays are behind us, we are just about to settle down for the winter's work, and enough of the financial year has passed to make it reasonable for the Chancellor to say something about the way in which things are going.'

So how are things going? Let me say a few words about the Bank's responsibility for communication in three areas: monetary policy, the management of financial crises, and the oversight of payment systems.

Communication with financial markets and the general public is a key part of the responsibilities of the Monetary Policy Committee. In our speeches, the *Minutes* of our monthly meetings and our quarterly *Inflation Reports*, we strive continuously to stress the importance of uncertainty in the economic outlook. We try to explain both what we think we do know and — as importantly — what we don't know. Judging the balance of risks is very different from pretending to foresee the future. Looking ahead is a necessary part of our policy process because of the lags between decisions on interest rates and their impact on spending, output and, finally, prices. But we must remain conscious of the limitations on our ability to forecast the future path of the economy. The certainty with which many commentators present their views is, frankly, bizarre. Too often, forecasters seem to be the unfathomable in pursuit of the unpredictable.

The essence of monetary policy is to reduce uncertainty by anchoring inflation expectations. Most discussion of

(1) Given on 22 June 2005. This speech can be found on the Bank's website at www.bankofengland.co.uk/publications/speeches/2005/speech250.pdf.

monetary policy sees policy as a series of discretionary decisions on interest rates. But monetary policy is more than that. It is a regime for setting policy, and it is the regime, rather than individual decisions on interest rates taken month by month, which anchors inflation expectations to the 2% target. A key reason for having an explicit target for inflation is to make it easier for businesses and households to form their expectations of inflation. Interest rates will be expected to respond to developments in the economy in a predictable way.

The MPC tries to make monetary policy predictable not by giving hidden signals and subtle clues in speeches — including this one — as to where interest rates will go next, but by explaining our interpretation of the data. We do not make up our mind about interest rates before the policy meeting takes place, and we do so only in the light of an appraisal of all the information available then.

So what do we make of the data? Our most recent assessment is contained in the MPC *Minutes* published this morning. The starting point is that inflation is very close to target and the economy is still growing at a rate not far from its long-run average. But final domestic demand growth has weakened for five consecutive quarters. Some easing was desirable in order to bring about a rebalancing of the economy. But inevitably it increases the uncertainty about whether net external demand will compensate for weaker domestic demand. It is unlikely that growth will be as smooth in the future as it was over the past decade.

Those concerns have been fuelled by the sharp slowing of consumer spending in recent months. The weakness in sales of goods on the high street has been marked. Nevertheless, consumption of services appears, at least so far, to be more resilient. So it is possible that we are seeing a temporary slowdown in spending, although we cannot be sure.

The risks around that view are the key to policy. The main downside risk to activity and inflation is the immediate outlook for demand: consumer spending, business investment and exports. In particular, if the weakness in spending on goods were to spread to services then the slowdown in consumption growth would be more protracted.

The main upside risk stems from signs of cost pressures on business. Import prices, which had been falling for several years, are now rising. And it is still unclear whether the rise in inflation from 1.1% to 1.9% in just six months reflected generalised demand pressures or purely temporary factors.

Judging the balance of those risks is a difficult task. What matters most is that the Monetary Policy Committee will react promptly to whichever of these risks appears to be materialising in the months ahead, and will continue to communicate its thinking regularly to both the markets and the wider public.

Communication in times of financial crisis is very different. The irregularity and, we hope, the infrequency of crises precludes the strategy of regular communications appropriate to monetary policy. Nevertheless, it is important that we communicate to you and others in the financial world how such crises would be managed. Although we try to assess and communicate financial vulnerabilities (in the *Financial Stability Review*, for example), no system of monitoring can spot all threats to the stability of the financial system as a whole, nor hope to avert all crises. Managing crises is the responsibility of the Standing Committee comprising the Treasury, FSA and the Bank. Contingency planning for such events is essential. Within the Bank our arrangements have been tested in a series of exercises involving studies of past crises, such as the failure of Barings in 1995, as well as hypothetical new scenarios. I can assure you that the tripartite arrangements exist not only on paper but in an agreement on how minute-by-minute co-ordination of the operations of the Bank and FSA would work during any crisis. That is something which Callum McCarthy and I have been keen to promote, and the details will be announced in the Autumn.

A third area in which communications are an important policy instrument is the Bank's oversight of payment systems, a responsibility mandated by the 1997 Memorandum of Understanding. Since the 18th century, the Bank of England has been at the apex of the payment system in this country, largely as the provider of the asset in which other financial institutions settle — central bank money. Today, one of our key roles is to ensure that UK payment systems are resilient in the face of shocks — such as the unexpected default of a major institution or a significant operational disruption. The Bank has increased transparency about its assessment of risks to UK payment systems through the publication of the first *Payment Systems Oversight Report* earlier this year. Transparency should help to reduce risks by prompting remedial action by the

operators of and participants in the relevant payments systems. Like the *Inflation Report*, the new *Oversight Report* aims to put the Bank at the cutting edge of best practice.

There are several areas, identified in the *Report*, where further remedial action is needed. Last year I mentioned the need to reduce settlement risk in the major UK retail payment systems. Since then encouraging progress has been made. And in the Payment System Task Force, chaired by the OFT, there is now agreement to introduce a same-day clearing service for electronic payments made by individuals and businesses. That should deliver both lower risk and greater efficiency for the general public. I very much hope that one year from now we will have seen real progress towards implementation.

So in three areas — determining monetary policy, limiting the damage from crises, and overseeing payment systems — communication is at the heart of the work of the Bank of England.

There was a time when communication between the Bank and the City was simpler: when one of the main drivers of the demand for credit was the direction of the wind, easily observed by all, which indicated when conditions were favourable for ships to enter or leave the port of London. Although communications have evolved a great deal since those days, the Bank, believe it or not, still has a weather vane in its Court Room and shipping remains important to the City. One half of world seaborne trade may be unloaded in Asia, but almost one half of the ships involved are bought, sold and chartered in London by members of the Baltic Exchange.

Lord Mayor, you have made 'Maritime London' the theme of your mayoralty, and how appropriate in the year in which we celebrate Nelson's victory at Trafalgar. Indeed, if this dinner had been held in October we could have celebrated that great victory with the merchants and bankers whose predecessors helped to finance it.

Tonight all of us here would like to pay tribute to your work since you became Lord Mayor, and to thank both the Lady Mayoress and yourself for the splendid hospitality which you have extended to us all this evening.

So I invite you all to rise and join me in the traditional toast of good health and prosperity to The Lord Mayor and the Lady Mayoress.

Monetary policy making: fact and fiction

In a speech[1][2] at the South West Agency in May 2005, Richard Lambert, member of the Monetary Policy Committee, reflected on lessons about the process of setting monetary policy. He argued that in monetary policy it is critically important to recognise the lack of certainty about the key issues and he set out ways of coping with those uncertainties.

This week marks the end of the second year of my three-year term as a member of the Monetary Policy Committee. It seems like a good moment to reflect on what I have learnt over that period about the process of setting monetary policy, and on how things look from my perspective today.

As someone who is not a professional economist, there is no doubt that I did have a great deal to learn. But my biggest single lesson has not been about abstruse theory or econometric modelling. It's been about something much more simple — something which came as rather a surprise to someone from my background in newspapers.

It's been about uncertainty.

In journalism, certainty is what matters. You generally need to express your views with the absolute confidence that anyone who disagrees with you is a fool or a knave.

In monetary policy, exactly the opposite is true. It is critically important to recognise the lack of certainty about all the key issues which have to be addressed. There are some concepts to help clarify the mind about how things stand today, and how they might look in a couple of years' time. And there are some yardsticks against which to judge the appropriateness of this or that course of action.

But few of them are directly measurable, or easily observable. Most of them are built on assumptions which may simply be wrong, and on data which are subject to revision. And all of them may be subject to different interpretations at different stages of the economic cycle.

In other words, there are no set rules.

This uncertainty applies to even the most basic questions, such as: is the current rate of interest accommodative — meaning is it low enough to encourage credit growth and economic expansion? Or is it restrictive, in the sense that it is squeezing down on animal spirits and cutting back demand?

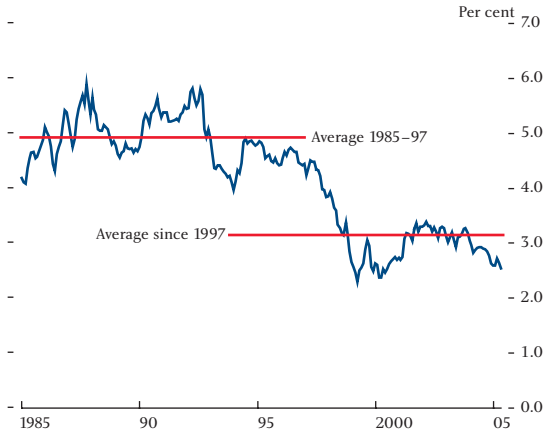
The so-called neutral rate of interest is the level at which economic activity would grow at a sustainable rate over time, while also keeping inflation under control. One way of arriving at this magic number is to estimate the neutral real interest rate, and add to that figure the inflation target to arrive at the appropriate nominal interest rate. When I joined the Committee, there seemed to be a pretty solid consensus among outside pundits that the neutral nominal rate stood somewhere around 5% to 5.5%. That view was based on the idea that the long-term real rate was probably in the region of 2.5% to 3%, while the inflation target — then pinned on the RPIX measure — was 2.5%.

But the problem is that the neutral real rate is not a constant. Instead, it varies over time, depending on a host of changing circumstances such as the rate of productivity growth, fiscal policy and the rate of savings both at home and abroad. Moreover, estimates of the average neutral rate will vary depending on what period of time is taken into consideration. A crude proxy for the neutral real rate taken from index-linked gilts

(1) Given on 24 May 2005. This speech can be found on the Bank's website at www.bankofengland.co.uk/publications/speeches/2005/speech247.pdf.
(2) I am grateful to Alison Stuart and Michael Sawicki for help in preparing this speech. I have also benefited from comments and discussions with many colleagues at the Bank. The views expressed here are personal and should not be interpreted as those of the Bank of England or other members of the Monetary Policy Committee.

(between five and ten years ahead) reached almost 6% in the late 1980s but had fallen to under 4% ten years later (Chart 1).

Chart 1
Forward real interest rates between five and ten years ahead



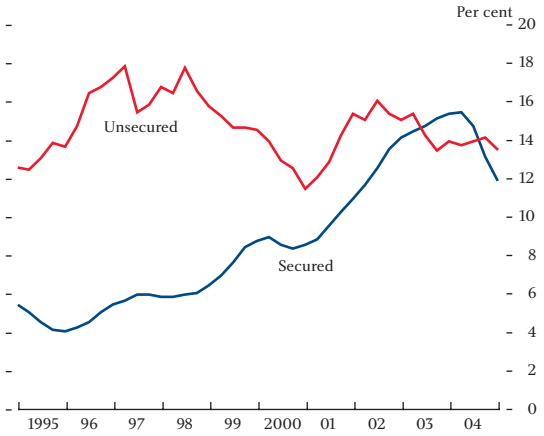
Note: Calculated as the average index-linked yield on government bonds in five to ten years' time, adjusted by the average difference between CPI and RPI inflation since 1989.

More recently, the rate appears to have edged down further (to around 2.5%). There are several possible explanations for this, including demographic change, investment demand, international flows of savings, or more market-specific factors. Since we can't be certain about the relative importance of these competing explanations, we can't be confident about where real rates might go from here. And this in turn means it is impossible at any moment in time to pin down the neutral rate with the degree of precision necessary to use it as a guide to each month's decision.

It seemed easy enough when I joined the Committee two years ago: the Bank's repo rate had been declining for three years and at 3.75% was close to what turned out to be the trough. That, it was clear to me, was an accommodative rate whichever way it might be assessed.

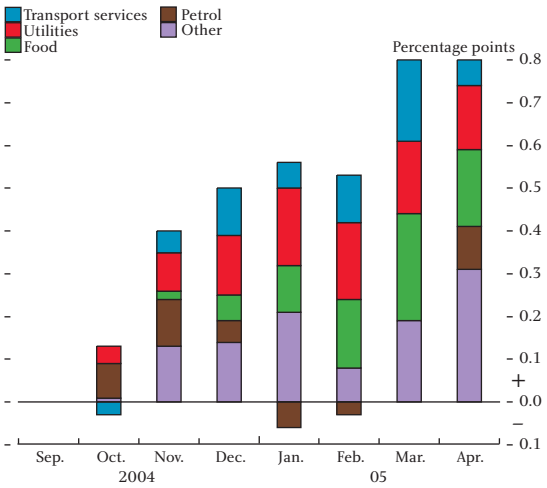
But with rates now up at 4.75%, the picture is much less clear. In nominal terms, this is a modest figure by the standards of recent economic cycles. There seems to be plenty of liquidity available in the corporate sector and although the growth in secured borrowing by retail customers has slowed down a bit with lower house price inflation and the fall in housing market transactions, demand for unsecured borrowing remains strong (Chart 2).

Chart 2
Annual growth in secured and unsecured lending



Inflation as measured by the consumer prices index has risen more sharply than expected from its low point last September, and not exclusively because of the impact of higher oil prices (Chart 3). Producer output price inflation has picked up smartly in the past three years (Chart 4). And there is reason to think that import prices will also be pushing up on inflation over the next year or two. All this could suggest that interest rates might need to rise a little further in order to ensure that inflation remains low and stable over time. But other evidence points in a different direction.

Chart 3
Contributions to increase in CPI inflation since September 2004



Consumers seem to have become distinctly more cautious about their spending habits in recent months. Growth in household consumption slowed sharply to just 0.2% in the final quarter of 2004, and gloomy news from the high street, from the car saleroom, from surveys, and from the Bank's regional Agents suggest that conditions have not got much better so far this year.

Chart 4
Producer output price inflation

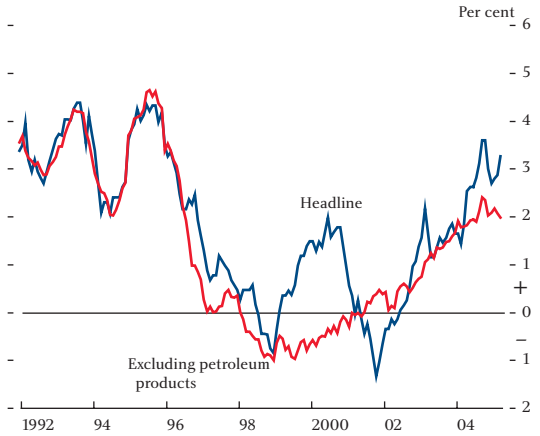
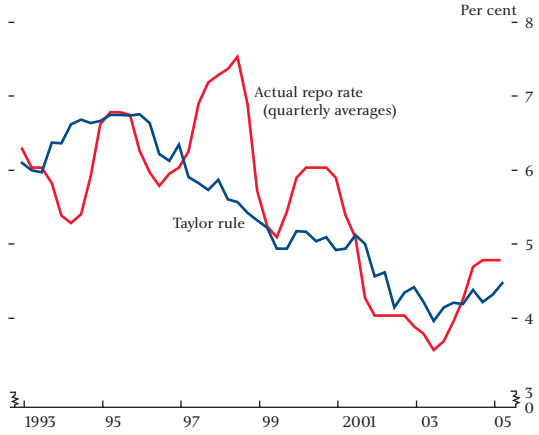


Chart 5
Official rate and rate implied by Taylor rule



Note: The equilibrium real interest rate assumed for the Taylor rule is the HP-filtered trend of the five-year real forward rate five years out, adjusted upwards to reflect the average difference between CPI and RPI inflation. Weights on the output gap and deviations of inflation from target are both equal to 0.5. Output gap is the deviation of real GDP from HP-filtered trend over period 1955 Q1 to 2005 Q1.

It's not clear precisely what's behind the recent weakness of consumption considering that employment growth has picked up a little, real incomes are in reasonable shape, and the housing market appears to have stabilised. Against this background, it certainly is not obvious to me that interest rates are currently set too low to ensure low and stable inflation in the years to come.

This view is reinforced by the latest numbers from the manufacturing sector, which have been surprisingly weak.

Of course there are other tools you can deploy to help form a judgement about where interest rates should stand. One much-used example is the Taylor rule, under which interest rates are raised or lowered according to whether current output is above or below trend, and current inflation is above or below the target. But this rule is backward looking and does not take into account other information that might be pertinent to the outlook for inflation. It also requires an assessment of the neutral real interest rate and an assessment of spare capacity. So once again, such rules can help to clarify thinking, but do not provide a precise guide to the appropriate interest rate.

Depending on how the different variables are assessed, the Taylor rule would point at present to an interest rate somewhat *below* the current level (Chart 5).

In this example, one big uncertainty is about the level of spare capacity in the economy — an issue which I've spent many happy hours discussing over the past two years.

Setting a course for monetary policy requires some assessment to be made about the pressure of aggregate demand relative to the economy's productive potential. If there appears to be quite a bit of capacity left to be filled before bottlenecks start to appear, interest rates may be kept lower than otherwise would have been the case without leading to a build-up of inflation.

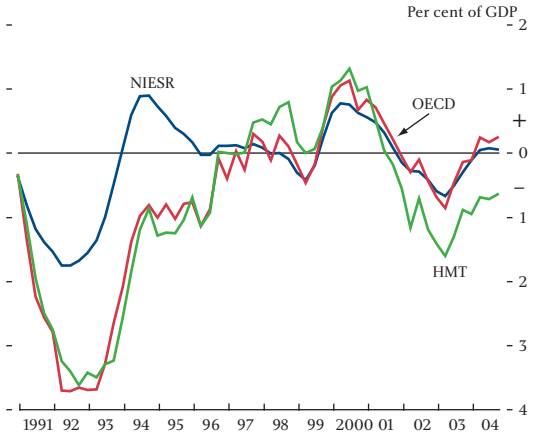
For example, growth in the American economy has been above its long-run average for much of the past year or so. But there has been enough spare capacity in the system to permit the Fed to raise interest rates at a measured pace from their historically low levels.

The percentage difference between the level of GDP consistent with the sustainable full employment of resources and the current level of real GDP is described as the output gap. I've learnt that this is another important but extremely slippery concept.

One way of demonstrating this slipperiness is to look at current estimates of the output gap in the United Kingdom (Chart 6). On the Treasury's version, the economy is running comfortably below its productive potential, with noticeably more spare capacity than was available in the late 1990s. No obvious reason to worry about inflationary bottlenecks here.

But according to the OECD's *Economic Outlook*, which is published today, the opposite is true: the economy is already operating close to, or slightly above, capacity and capacity constraints are a little higher than was the case through most of the 1990s.

Chart 6
Output gap estimates



Sources: HM Treasury, NIESR and OECD *Economic Outlook*.

The National Institute of Economic and Social Research, in its latest analysis published last month, also suggests that relatively strong growth in the recent past means that the output gap has now closed. Although capacity constraints are not expected to be as tight as they were around 2000–01, the National Institute says that further expansion in the coming months will bring 'some signs of emerging inflationary pressures'.

To be fair, the three institutions draw up their numbers on a different basis, which means they are not directly comparable. But the challenges for monetary policy makers are obvious. Estimates about the level of spare capacity have to be constantly adjusted as new evidence comes in. And quite small changes in these assumptions can lead to quite sizable changes in estimates of the future levels of price inflation.

Big mistakes here can lead to big trouble. An estimate by Bank of England economists a few years ago suggested that monetary policy errors due to output gap mismeasurement contributed between 3 and 7 percentage points to average UK inflation in the 1970s, and between 1 and 6 percentage points in the 1980s.(1)

Rather than concentrating simply on a single measure of the output gap, the MPC likes to look more broadly at the balance between supply and demand in both the product and the labour markets. Here again, it is impossible to draw precise conclusions. But helpful ways of thinking about the challenge were contained in the Bank's previous two *Inflation Reports*, for February and for May. An article in the February *Report* took a look at factor utilisation in the private sector: how hard private sector companies are using their capital and labour. This examined a number of measures of productivity and the intensity with which companies were using capital and labour, and compared the results with the surveys of capacity utilisation produced by the CBI and the British Chambers of Commerce.

The conclusion was that companies taken in aggregate did appear to be working at or above their normal levels of capacity. This is consistent with reports from the Bank's regional Agents, and with what many companies themselves are saying. And if it were to be sustained over time, it would eventually push up on the pace of consumer price inflation.

Factor utilisation is one aspect of the balance between the demand for private sector output and the resources required to produce it. The other is the tightness of the labour market, which is the subject of an article in this month's *Inflation Report*. The degree of labour market tightness depends on the extent to which demand for labour is matched by the potential supply of workers who are able and willing to take on jobs. If companies find it difficult to hire and retain people, there is likely to be upward pressure on their wage costs which they may seek to pass on by pushing up the selling price of their goods and services.

Before I joined the Committee, I'd read many pundits who agreed that the MPC got very uncomfortable when the annual rate of wage increases exceeded 4.5%. This view, I discovered, stemmed from comments in *Inflation Reports* back in the late 1990s to the effect that — given the United Kingdom's historic levels of productivity growth of roughly 2% a year and the then inflation target of 2.5% — it would indeed be something to worry about if average earnings grew by much more than this figure over a sustained period without clear signs of an improvement in underlying productivity growth.

But alas, this too was yet another number which did not turn out to be very helpful when thinking about the appropriate level for interest rates. For one thing, the MPC has a symmetric target: it has to be just as worried about inflation turning out to be too low as it is about inflation being too high. On this reading, therefore, it should also get uncomfortable if average earnings rose

(1) Nelson, E and Nikolov, K (2002), 'UK inflation in the 1970s and 1980s: the role of output gap mismeasurement', *Bank of England Working Paper no. 148*.

by much less than this figure for a prolonged period, which of course has been the case for much of the past few years.

For another, the MPC is not in the 'stop-go' business: it does not wait until a particular data series passes a particular spot and then slam on the brakes. Much better to study the trends, exploring whether changes are temporary or structural, and — when appropriate — lean against them gradually, rather than waiting to do anything until the last minute.

Finally and most important, the Committee does not form its views about the labour market simply on estimates of the growth of average earnings. Rather it bases its judgements on a view of the overall tightness of the labour market, which means looking at movements in supply and demand as well as in wages. As with everything else, no single piece of evidence is decisive.

One big question here is about the equilibrium unemployment rate, that is the level of unemployment consistent with stable inflation. If this figure could be assessed with any degree of precision, it would provide a much better view of capacity constraints in the labour market at any given moment than otherwise would be the case.

But once again this is a moving target. Four years ago, Committee member Steve Nickell and his co-author Glenda Quintini showed how, on one measure, the equilibrium unemployment rate in the United Kingdom had fallen from nearly 10% in the late 1980s to under 6% by the late 1990s — the result among other things of the reduction in the power of trade unions, along with changes in benefits and employment taxes, and in product market competition.(1)

It's a fair bet that the equilibrium unemployment rate has fallen further in recent years, helping to explain why wage inflation has remained relatively subdued despite rising levels of employment.

The article on labour market tightness in the latest *Inflation Report* looks at a range of indicators and business surveys and suggests that conditions have not got tighter over the past twelve months: it may be the case that they have slackened a little. One possible explanation is that the relative strength of the UK economy has pulled in more workers from overseas. Indeed, it may be the case that old ideas about equilibrium unemployment and the output gap may have to be rethought in a world of free movement of labour across much of the European Union.

On this view of factor utilisation and the labour market, the overall economy may be running somewhere around — but not much above — its productive potential. That could point to some inflationary pressure in the economy but would not suggest that things are getting out of hand.

In its efforts to understand the data, the Committee spends a lot of time trying to sort out the news from the noise — in other words, aiming off for statistical aberrations or for data that past experience shows are particularly subject to revision. I will mention two current examples.

One concerns the long-term decline in the average hours worked across the UK economy, a pattern which stretches back over decades and which has been particularly marked over the past ten years. This appears to have been driven in good measure by structural changes, such as increased demand for flexible working as female participation in the workforce has risen, and a general tendency to reduce working hours as society gets more prosperous. More recently measures such as the Working Time Regulations are likely to have reduced average working hours yet further. If the fall in average hours is indeed the result of structural changes, then the implication would be that the level may have been permanently reduced.

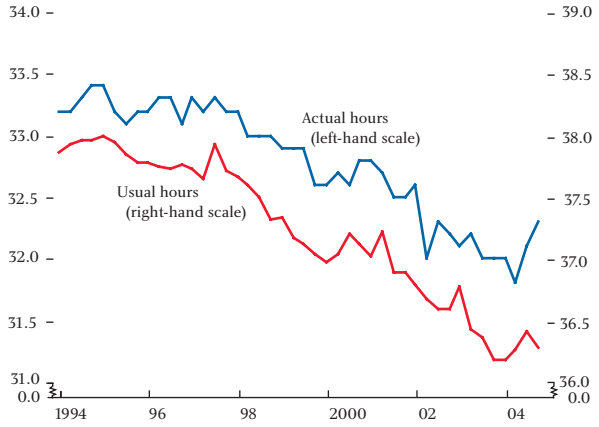
In the past few months, however, the average for all workers has crept up a little to 32.2 hours a week. This modest-looking increase, if it's really happening, would add up to a measurable increase in the supply of available labour. On one interpretation, that might help to take the heat out of wage inflation, if it were permanent. On another, it might suggest that businesses were finding it difficult to recruit new employees to cope with increased demand, and so could presage some pickup in wages and inflationary pressures.

Yet there are reasons for thinking the latest numbers may represent some kind of measurement error: for one thing, a measure of usual hours worked has not risen to

(1) Nickell, S and Quintini, G (2002), 'The recent performance of the UK labour market', *Oxford Review of Economic Policy*, 18/2.

the same extent (Chart 7). For the time being, then, put this one down to noise more than news.

Chart 7
Average hours worked



A different example: I've already mentioned the view that the growth in household consumption — which played a vital part in the overall economic expansion of the past decade — is slackening. But past experience shows that initial readings of consumption — such as the official data for the final quarter of 2004 — are subject to quite sizable revisions. There have been times — such as in the summer of 1998 — when what at first looked like a marked slowdown was subsequently largely revised away. And on other occasions, such as the second quarter of 2003, consumption rapidly bounced back after a weak first quarter.

This time, though, the tales of gloom from the high street, and from some other consumer sectors, are too consistent to suggest that what we have seen so far is just a statistical aberration. The picture is far from clear, since retail sales represent a little less than two fifths of household consumption. But in this case, it seems to me, there may be more news than noise in the latest readings.

Another challenge, I've learnt, is that data can be highly volatile. One example: through most of the first half of 2004, inflation as measured by the consumer prices index was coming in noticeably below the MPC's central expectation. The CPI, as you remember, had replaced the RPIX measure as the official target from December 2003.

By the late summer, the rate was running at not much more than 1%, and since the CPI had not reached 2% for around seven years, I confess that I was beginning to worry that the path back up to the new 2% target could turn out to be improbably steep.

The central projection in last August's *Inflation Report* was that the target would be reached in the summer of 2006. As it turned out, though, it took little more than six months for the CPI to rise to its current rate of 1.9%, and on our latest central projection we will reach the 2% mark in the very near future.

This is not in itself a cause for alarm. The MPC is set a symmetric inflation target, which means that over time the rate of inflation will inevitably run above as well as below the target.

It is true that the past decade has seen a period of unusual stability in the UK economy, with output growing steadily and inflation remaining low and stable. But the next few years may well be more challenging.

There is no longer a sufficient margin of spare capacity to offset unexpected price increases, and we cannot expect import prices to keep dragging down on inflation in the way that they have done in recent years. So when the economy is hit by a shock, such as the steep rise in oil prices, we may have to get used to a world where the relationship between output and inflation changes, and looks less benign. And where, for a period, output slows below trend but inflation rises a little above target as cost pressures feed through the supply chain.

So monetary policy is a process in which there are no set rules, where most of the data are subject to revision, and where trend lines can shift with surprising speed. Does this mean that decisions about monetary policy are entirely a matter for the Committee's discretion, and that its members are permanently blundering around in the fog?

The answer to both questions is, of course, a resounding 'no'.

The Committee does not have endless room for discretion: to the contrary, it is subject to the overriding and ever-present requirement of its statutory mandate — to maintain price stability as defined in the inflation target and, subject to that, to support the Government's objectives for growth and employment. This is the sole objective at which policy is directed, and against which the Committee's performance must be assessed. It imposes a powerful discipline on our

monthly meetings and keeps our attention permanently focused on the key issues. The quarterly forecast round and publication of the *Inflation Report* also discipline the Committee to consider how the economic jigsaw fits together. Discussions are aided by the Bank's quarterly forecasting model which provides a coherent and consistent framework for thinking about the way the economy functions. And the Committee also spends a long time considering alternative models and the uncertainties and risks surrounding particular forecasting judgements.

As for ways of coping with the uncertainties I have described, I would like to mention six that I have found important over the past two years.

1 Consider as wide a range of information inputs as possible, but be aware that some are worth a lot more than others. Beware of anecdote and gossip. One of the things that surprised me as a newcomer to the Bank was the sheer strength and professionalism of its economic analysis — an extraordinary resource, which among other things helps the Committee to understand what bits of data are more reliable than others, how to use the business surveys to supplement official data, and how to make intelligent guesses about underlying economic trends. I'd been in and out of the Bank many times over the years, but I had not appreciated quite how strong it has become in this respect.

2 Don't get too carried away by the latest data — there's a temptation to do so, given the regular programme of monthly MPC meetings and the constant stream of economic news from around the world. The fact that, say, US non-farm payrolls may turn out a shade higher or lower in a single month than the markets expected may make an interesting headline, but is not by itself going to do much to change the UK outlook.

3 Instead, concentrate on the big picture and on the issues which would lead to trouble if the Committee got them badly wrong. The quarterly *Inflation Report* round, which takes the form of a whole series of lengthy Committee meetings, provides a wonderful opportunity to clarify the mind. And the monthly meetings, focusing on the outlook for future inflation, provide a regular check on whether the economy is moving along the expected lines. Forecasting errors can be corrected, and judgements adjusted accordingly.

4 Forecasts of economic growth and inflation are not to be translated into policy in a mechanical way and Committee members do have to be ready to exercise their judgement. February's *Inflation Report*, on the central projection, had the CPI rising at 2.2% after year two and by 2.3% at year three. Since the Committee's view was that the economy was rising at close to its trend rate and operating at or a little above its potential capacity, this, on the face of it, could have been a reason for pushing interest rates higher at that time. But the Committee always looks carefully at the risks surrounding the forecast. In February it concluded that the risks to both growth and inflation were somewhat on the downside, thanks — among things — to uncertainty about the outlook for consumer spending and the prospects for the global economy. This, for most members, was reason enough to leave the rate unchanged at that and subsequent meetings.

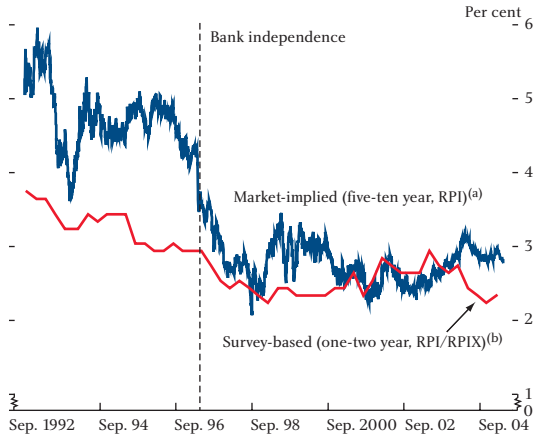
5 The structure and make-up of the Committee is itself an invaluable aid to sound decision making. A small group of people with a diverse set of experiences but a single objective can challenge each other's assumptions and learn from their mistakes. There is enough continuity on the MPC to provide a collective memory of how problems were tackled on similar occasions in the past, and enough fresh thinking to bring new ideas to bear. Studies in both the United States and the United Kingdom suggest that groups of people who are prepared to debate with and learn from each other are capable of producing better results than their smartest individual member, and my experience of the past two years has convinced me of why this is the case.(1)

6 Finally, the trend in inflation expectations is a matter of critical importance to the Committee. Here again there are no precise observations. Readings differ a little depending on whether they are extrapolated from the financial markets or from surveys, and expectations cannot themselves be targeted. Instead, they are shaped by the extent to

(1) Blinder, A S and Morgan, J (2000), 'Are two heads better than one: an experimental analysis of group vs individual decision making', *NBER Working Paper no. 7909*, September; Lombardelli, C, Proudman, J and Talbot, J (2002), 'Committees versus individuals: an experimental analysis of monetary policy decision-making', *Bank of England Working Paper no. 165*.

which the conduct of monetary policy is seen to be credible. But so long as expectations remain as they are, anchored firmly around the target, that makes the job of the Committee — to meet its mandate of low and stable inflation — much more manageable (Chart 8).

Chart 8
Inflation expectations



Note: RPI is the measure of inflation used for index-linked bonds, but is not the target measure of inflation in the United Kingdom. RPI will differ from both RPIX and CPI, which partly reflects the coverage of the index: for example, RPI includes mortgage interest payments. In addition, RPI will typically be higher than CPI due to a formula effect, as the arithmetic mean rather than the geometric mean is used to aggregate individual prices within expenditure categories.

Sources: Bank of England, Consensus Economics and ONS.

(a) The difference between five-year forward, five-year yields on conventional and index-linked gilts.
(b) Consensus Economics survey expectations for one to two years ahead.

For a good part of my time on the MPC, the decision-making process seemed rather straightforward. By the late autumn of 2003, it was clear that the economy was picking up steam and that interest rates, at a 50-year low of 3.5%, were heading higher. The only real question was about how rapid the increases should be, and since we had made it plain that we favoured a gradual approach to rate increases, there wasn't even much room for argument about that.

More recently, though, the task has become more challenging. It's true that the central projections in our latest *Inflation Report*, for May, look remarkably benign: the economy growing around trend, inflation pretty well bang on target for most of the next three years, market expectations of interest rates moving sideways at around their current level for years to come. The weakness in consumption turns out to be temporary, and the recent upswing in consumer price inflation is not sustained.

But that may turn out to be too rosy a view. I've already mentioned the question marks over consumption, which represents over three fifths of GDP. Government spending, representing around a fifth of GDP, is no longer accelerating. And the US news is a little less buoyant than it was a few months ago, while the euro area remains sluggish.

At the same time, there are a few signs that inflationary pressures may be building a little around the world, and not just as a result of higher oil prices. After falling for much of the past six years, consumer price inflation for goods moved up to around zero in March and April, while that for services has edged up to 4%. Pressures from the supply chain may continue, and import prices may start to edge higher.

So my third year on the Committee may turn out to be even more interesting and challenging than the first two. I look forward to it with enormous enthusiasm.

Bank of England speeches

Speeches made by Bank personnel since publication of the previous *Bulletin* are listed below.

Monetary policy challenges facing a new MPC member.
Speech by David Walton, member of the Monetary Policy Committee, at a lunch with the Exeter business community, in Exeter on 16 September 2005. www.bankofengland.co.uk/publications/speeches/2005/speech254.pdf.

Jackson Hole Symposium.
Remarks by Mervyn King, Governor, to the Central Bank Governors' Panel in Wyoming, United States on 27 August 2005.
www.bankofengland.co.uk/publications/speeches/2005/speech253.pdf.

Jackson Hole Symposium.
Speech by Charlie Bean, Chief Economist, commenting on a paper by Bob Hall entitled 'Separating the business cycle from other economic fluctuations' in Wyoming, United States on 26 August 2005.
www.bankofengland.co.uk/publications/speeches/2005/speech252.pdf.

Euromoney global borrowers and investors forum.
Remarks by Paul Tucker, Executive Director and member of the Monetary Policy Committee, to the session 'Where are the risks?' at The London Hilton on 23 June 2005. www.bankofengland.co.uk/publications/speeches/2005/speech251.pdf.

Mansion House Dinner.
Speech by Mervyn King, Governor, at the Lord Mayor's Banquet for Bankers and Merchants of the City of London at the Mansion House on 22 June 2005. www.bankofengland.co.uk/publications/speeches/2005/speech250.pdf. Reproduced on pages 385–87 of this *Bulletin*.

Comments by Stephen Nickell on a paper by Romain Duval and Jorgen Elmeskov 'The effects of EMU on structural reforms in labour and product markets'.
At a conference held at the European Central Bank, Frankfurt, 16–17 June 2005.
www.bankofengland.co.uk/publications/speeches/2005/speech249.pdf.

Dinner at Salts Mill in Bradford, Yorkshire.
Speech by Mervyn King, Governor, on 13 June 2005. www.bankofengland.co.uk/publications/speeches/2005/speech248.pdf.
Reproduced on pages 382–84 of this *Bulletin*.

Contents of recent Quarterly Bulletins

The articles and speeches that have been published recently in the *Quarterly Bulletin* are listed below. Articles from November 1998 onwards are available on the Bank's website at www.bankofengland.co.uk/publications/quarterlybulletin/index.htm.

Articles and speeches (indicated S)

Autumn 2004

How should we think about consumer confidence?
Household secured debt
Housing equity and consumption: insights from the Survey of English Housing
Why has world trade grown faster than world output?
The institutions of monetary policy (S)
The Governor's speech to the CBI Scotland dinner (S)
The Governor's speech at the Mansion House (S)
Keeping the party under control—anniversary comments on monetary policy (S)
Some current issues in UK monetary policy (S)
Managing the central bank's balance sheet: where monetary policy meets financial stability (S)
Household debt, house prices and consumption growth (S)

Winter 2004

British household indebtedness and financial stress: a household-level picture
The new sterling ERI
Using option prices to measure financial market views about balances of risk to future asset prices
The foreign exchange and over-the-counter derivatives markets in the United Kingdom
The external balance sheet of the United Kingdom: recent developments
Stability and statistics (S)
Why is inflation so low? (S)
Monetary policy, data uncertainty and the supply side: living with the statistical fog (S)

Spring 2005

Dealing with data uncertainty
Indicators of short-term movements in business investment
Divisia money
Inside the MPC
The role of central banks in payment systems oversight
The Governor's speech to the CBI Dinner in Manchester (S)
The Governor's speech on the International Monetary System (S)
Why monetary stability matters to Merseyside (S)

Spring 2005 (continued)

Monetary policy in an uncertain world (S)
Why has inflation been so low since 1999? (S)
The housing market and the wider economy (S)

Summer 2005

The impact of government spending on demand pressure
How important is housing market activity for durables spending?
The inflation-targeting framework from an historical perspective
Monetary policy news and market reaction to the *Inflation Report* and MPC *Minutes*
Addendum to *Report on modelling and forecasting at the Bank of England*
Public attitudes to inflation
Chief Economist Workshop April 2005: exchange rate regimes and capital flows
Implementing monetary policy: reforms to the Bank of England's operations in the money market
A review of the work of the London Foreign Exchange Joint Standing Committee in 2004
Monetary policy: practice ahead of theory
The Mais Lecture 2005: speech by the Governor (S)
Inflation targeting in practice: models, forecasts and hunches (S)
Monetary policy, stability and structural change (S)
How much spare capacity is there in the UK economy?
Communicating monetary policy in practice (S)
Monetary policy in the United Kingdom — the framework and current issues (S)
A matter of no small interest: real short-term interest rates and inflation since the 1990s (S)

Autumn 2005

Assessing the MPC's fan charts
Long-run evidence on money growth and inflation
The determination of UK corporate capital gearing
Publication of narrow money data: the implications of money market reform
The Governor's speech at Salts Mill, Bradford (S)
The Governor's speech at the Mansion House (S)
Monetary policy making: fact and fiction (S)

Bank of England publications

The Bank of England publishes information on all aspects of its work in many formats. Listed below are some of the main Bank of England publications. For a full list, please refer to our website www.bankofengland.co.uk/publications/index.htm.

Working papers

An up-to-date list of working papers is maintained on the Bank of England's website at www.bankofengland.co.uk/publications/workingpapers/index.htm, where abstracts of all papers may be found. Papers published since January 1997 are available in full, in PDF.

No.	Title	Author
249	Optimal collective action clause thresholds *(February 2005)*	Andrew G Haldane Adrian Penalver Victoria Saporta Hyun Song Shin
250	Asset price based estimates of sterling exchange rate risk premia *(February 2005)*	Jan J J Groen Ravi Balakrishnan
251	The stock market and capital accumulation: an application to UK data *(February 2005)*	Demetrios Eliades Olaf Weeken
252	Real-Time Gross Settlement and hybrid payment systems: a comparison *(March 2005)*	Matthew Willison
253	Decomposing credit spreads *(March 2005)*	Rohan Churm Nikolaos Panigirtzoglou
254	On the consumption-real exchange rate anomaly *(March 2005)*	Gianluca Benigno Christoph Thoenissen
255	Learning the rules of the new game? Comparing the reactions in financial markets to announcements before and after the Bank of England's operational independence *(January 2005)*	Ana Lasaosa
256	Comovements in the prices of securities issued by large complex financial institutions *(March 2005)*	Christian Hawkesby Ian W Marsh Ibrahim Stevens
257	The role of ICT in the global investment cycle *(March 2005)*	Michael McMahon Gabriel Sterne Jamie Thompson
258	Estimating UK capital adjustment costs *(March 2005)*	Charlotta Groth
259	Productivity growth in UK industries, 1970–2000: structural change and the role of ICT *(March 2005)*	Nicholas Oulton Sylaja Srinivasan
260	Financial constraints and capacity adjustment in the United Kingdom: evidence from a large panel of survey data *(March 2005)*	Ulf von Kalckreuth Emma Murphy
261	Default probabilities and expected recovery: an analysis of emerging market sovereign bonds *(April 2005)*	Liz Dixon-Smith Roman Goossens Simon Hayes
262	The impact of unsecured debt on financial distress among British households *(April 2005)*	Ana Del-Río Garry Young
263	The determinants of unsecured borrowing: evidence from the British Household Panel Survey *(April 2005)*	Ana Del-Río Garry Young

264	Liquidity risk and contagion *(May 2005)*	Rodrigo Cifuentes Gianluigi Ferrucci Hyun Song Shin
265	Asset pricing, asymmetric information and rating announcements: does benchmarking on ratings matter? *(June 2005)*	Spyros Pagratis
266	The determinants of household debt and balance sheets in the United Kingdom *(July 2005)*	Merxe Tudela Garry Young
267	Bank loans versus bond finance: implications for sovereign debtors *(July 2005)*	Misa Tanaka
268	Forecasting using Bayesian and information theoretic model averaging: an application to UK inflation *(July 2005)*	George Kapetanios Vincent Labhard Simon Price
269	Accounting for the source of exchange rate movements: new evidence *(August 2005)*	Katie Farrant Gert Peersman
270	A model of bank capital, lending and the macroeconomy: Basel I versus Basel II *(August 2005)*	Lea Zicchino
271	Consumption, house prices and expectations *(September 2005)*	Orazio Attanasio Laura Blow Robert Hamilton Andrew Leicester
272	What caused the early millennium slowdown? Evidence based on vector autoregressions *(September 2005)*	Gert Peersman
273	'Real-world' mortgages, consumption volatility and the low inflation environment *(September 2005)*	Sebastian Barnes Gregory Thwaites
274	The substitution of bank for non-bank corporate finance: evidence for the United Kingdom *(September 2005)*	Ursel Baumann Glenn Hoggarth Darren Pain

External MPC Unit discussion papers

The MPC Unit discussion paper series reports on research carried out by, or under supervision of, the external members of the Monetary Policy Committee. Papers are available from the Bank's website at www.bankofengland.co.uk/publications/other/externalmpcpapers/extmpcpaper0000n.pdf (where n refers to the paper number). The following papers have been published recently.

No.	Title	Author
9	The pricing behaviour of UK firms *(April 2002)*	Nicoletta Batini Brian Jackson Stephen Nickell
10	Macroeconomic policy rules in theory and in practice *(October 2002)*	Christopher Allsopp
11	The exchange rate and inflation in the UK *(October 2002)*	Amit Kara Edward Nelson
12	Measuring the UK short-run NAIRU *(April 2003)*	Nicoletta Batini Jennifer Greenslade
13	UK consumers' habits *(May 2003)*	Ryan Banerjee Nicoletta Batini
14	National Accounts revisions and output gap estimates in a model of monetary policy with data uncertainty *(May 2005)*	Lavan Mahadeva Alex Muscatelli

Monetary and Financial Statistics

Monetary and Financial Statistics (*Bankstats*) contains detailed information on money and lending, monetary and financial institutions' balance sheets, banks' income and expenditure, analyses of bank deposits and lending, external business of banks, public sector debt, money markets, issues of securities, financial derivatives, interest and exchange rates, explanatory notes to tables and occasional related articles.

Bankstats is published monthly on the Internet but paper copies are available on a twice-yearly basis. Paper copies are published for the January and July editions in hard copy on Wednesday 2 February 2005 and Monday 1 August 2005 respectively. The price per annum in the United Kingdom is £40, or £20 per copy. *Bankstats* is available on a monthly basis free of charge from the Bank's website at www.bankofengland.co.uk/statistics/statistics.htm.

Further details are available from: Mark Thompson, Monetary and Financial Statistics Division, Bank of England: telephone 020 7601 5353; fax 020 7601 3208; email mark.thompson@bankofengland.co.uk.

The following articles have been published in recent issues of *Monetary and Financial Statistics*. They may also be found on the Bank of England's website at www.bankofengland.co.uk/statistics/ms/articles.htm.

Title	Author	Month of issue	Page numbers
A method for examining revisions to published statistics	Alison Franklin	July	20–21
Understanding the Bank of England's statistical requirements under International Financial Reporting Standards	Robert Westwood	June	16–19
Consolidated external claims of UK-owned banks: a new dataset	Kerry Baker	June	14–15
A new range of effective interest rates	Hannah Reynolds Michelle Ryan Jonathan Bailey	May	10–13
Seasonal adjustment of monetary data: annual review presentation	Martin Daines	April	9
A work programme in financial statistics — April 2005	Nick Davey	April	4–8
Average quoted household interest rates	Jonathan Bailey	February	1–3

Financial Stability Review

The *Financial Stability Review* is published twice a year, in June and December. Its purpose is to encourage informed debate on financial stability; survey potential risks to financial stability; and analyse ways to promote and maintain a stable financial system. The Bank of England intends this publication to be read by those who are responsible for, or have interest in, maintaining and promoting financial stability at a national or international level. It is of especial interest to policymakers in the United Kingdom and abroad; international financial institutions; academics; journalists; market infrastructure providers; and financial market participants. It is available from Financial Stability Review, Bank of England HO-3, Threadneedle Street, London, EC2R 8AH and on the Bank's website at www.bankofengland.co.uk/publications/fsr/index.htm.

Economic models at the Bank of England

The *Economic models at the Bank of England* book, published in April 1999, contains details of the economic modelling tools that help the Monetary Policy Committee in its work. The price of the book is £10. An update was published in September 2000 and is available free of charge.

The Bank of England Quarterly Model

The Bank of England Quarterly Model, published in January 2005, contains details of the new macroeconomic model developed for use in preparing the Monetary Policy Committee's quarterly economic projections, together with a commentary on the motivation for the new model and the economic modelling approaches underlying it. The price of the book is £10.

Practical issues arising from the euro

This is a series of booklets providing a London perspective on the development of euro-denominated financial markets and the supporting financial infrastructure, and describing the planning and preparation for possible future UK entry. Recent editions have focused on the completion of the transition from the former national currencies to the euro in early 2002, and the lessons that may be drawn from it. Copies are available from Public Enquiries Group, Bank of England, Threadneedle Street, London, EC2R 8AH and on the Bank's website at www.bankofengland.co.uk/publications/practicalissues/index.htm.

Payment Systems Oversight Report

The *Payment Systems Oversight Report* provides an account of how the Bank is discharging its responsibility for oversight of UK payment systems. Published annually, the *Oversight Report* sets out the Bank's assessment of key systems against the benchmark standards for payment system risk management provided by the internationally adopted Core Principles for Systemically Important Payment Systems, as well as current issues and priorities in reducing systemic risk in payment systems. Copies are available on the Bank's website at www.bankofengland.co.uk/publications/psor/index.htm.

Handbooks in central banking

The series of *Handbooks in central banking* provide concise, balanced and accessible overviews of key central banking topics. The *Handbooks* have been developed from study materials, research and training carried out by the Bank's Centre for Central Banking Studies (CCBS). The *Handbooks* are therefore targeted primarily at central bankers, but are likely to be of interest to all those interested in the various technical and analytical aspects of central banking. The series also includes *Lecture* and *Research* publications, which are aimed at the more specialist reader. All the *Handbooks* are available via the Bank's website at www.bankofengland.co.uk/education/ccbs/handbooks/index.htm.

Quarterly Bulletin

The *Quarterly Bulletin* provides regular commentary on market developments and UK monetary policy operations. It also contains research and analysis and reports on a wide range of topical economic and financial issues, both domestic and international.

Summary pages of the *Bulletin* from February 1994, giving a brief description of each of the articles, are available on the Bank's website at www.bankofengland.co.uk/publications/quarterlybulletin/index.htm.

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The Bank's quarterly *Inflation Report* sets out the detailed economic analysis and inflation projections on which the Bank's Monetary Policy Committee bases its interest rate decisions, and presents an assessment of the prospects for UK inflation over the following two years. The *Inflation Report* is available at www.bankofengland.co.uk/publications/inflationreport/index.htm.

The *Report* starts with an overview of economic developments; this is followed by six sections:

- analysis of money and asset prices;
- analysis of demand;
- analysis of output and supply;
- analysis of costs and prices;
- summary of monetary policy during the quarter; and
- assessment of the medium-term inflation prospects and risks.

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Quarterly Bulletin		*Inflation Report*	
Spring	14 March	February	16 February
Summer	20 June	May	11 May
Autumn	26 September	August	10 August
Winter	12 December	November	16 November

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